

WORK PACKAGE 2 WORK PLAN

HYDRODYNAMIC FIELD DATA COLLECTION AND CONTAMINANT SOURCE EVALUATION

PATRICK BAYOU SUPERFUND SITE REMEDIAL INVESTIGATION, DEER PARK, TEXAS

Prepared for

Patrick Bayou Joint Defense Group

Prepared by

Anchor Environmental, L.L.C.
1011 DeSoto Street
Ocean Springs, Mississippi 39564

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List of Acronyms and Abbreviations

ADCP	Acoustic Doppler Current Profiler
AGNPS	Agricultural Non-Point Source Pollution Model
Anchor	Anchor Environmental, L.L.C.
AOC	Administrative Order on Consent
BMP	Best Management Practices
cm	centimeter
COC	Chain-of-custody
COPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
dB	decibel
DCP	Data Collection Platform
DGPS	Differential Global Positioning System
DO	Dissolved Oxygen
EFDC	Environmental Fluid Dynamics Code
EMNR	Enhanced Monitored Natural Recovery
ERL	Effects Range –Low
FS	Feasibility Study
ft/s	foot per second
GBA	Gahagan & Bryant Associates Inc.
GIS	Geographic Information System
GPS	Global Positioning System
HCB	hexachlorobenzene
HCOEM	Harris County Homeland Security & Emergency Management
HDPE	high-density polyethylene
HGAC	Houston-Galveston Area Council
HSC	Houston Ship Channel
HSPF	Hydrological Simulation Program - FORTRAN
IDW	Investigation-Derived Waste
ISCO	Teledyne Isco, Inc.
JDG	Patrick Bayou Joint Defense Group
MLLW	mean lower low water
MNR	Monitored Natural Recovery
NAVD	North American Vertical Datum



List of Acronyms and Abbreviations

NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
OMS	Optical Monitoring System
PA	Pascal
PAHs	Polynuclear Aromatic Hydrocarbons
PCB	polychlorinated biphenyls
POC	Points of Contact
PPE	Personal protective equipment
ppt	parts per thousand
PSCR	Preliminary Site Characterization Report
PTFE	polytetrafluoroethylene
QA/QC	Quality assurance/quality control
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QEA	Quantitative Environmental Analysis, L.L.C.
RI	Remedial Investigation
Site	Patrick Bayou Superfund Site
SOP	Standard Operating Procedures
SWAT	Soil and Water Assessment Tool
SWMM	Storm Water Management Model
TCOON	Texas Coastal Ocean Observation Network
TEL	Total Equivalency Level
TMDL	Total Maximum Daily Load
TNRCC	Texas Natural Resource Conservation Commission
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
WMP	Waste Management Plan
WSE	Water Surface Elevation



1 INTRODUCTION AND PURPOSE

This Work Plan describes the rationale, study design, and methods for the collection of hydrodynamic data and sediment samples within the Patrick Bayou Superfund Site (Site) to meet the objectives for Work Package 2 outlined in the Remedial Investigation (RI) Work Plan (Anchor 2006b). The RI Work Plan is being conducted by the Patrick Bayou Joint Defense Group (JDG) in response to an Administrative Order on Consent (AOC) and Settlement Agreement with the U.S. Environmental Protection Agency (EPA) dated January 31, 2006.

The objectives for this phase of work include the following:

- Develop an understanding of the sediment transport mechanisms and the erosional and depositional characteristics of the Site.
- Conduct a contaminant source evaluation that focuses on evaluating potential ongoing contaminant contributions from off-site sources upstream of Highway 225 and the East Fork.
- Evaluate the depositional history and temporal nature of contaminant sources by vertically profiling the Site sediments for bulk and radio chemistry.

1.1 Site Description

Patrick Bayou is a tributary of the Houston Ship Channel (HSC) in Harris County, Texas. The Site originates south of State Highway 225 in the City of Deer Park, Texas, and flows approximately 2.5 miles in a northerly direction, discharging into the south side of the HSC approximately 2.3 miles upstream of its confluence with the San Jacinto River (Figure 1). The Site and its salient features are described in more detail in the Preliminary Site Characterization Report (PSCR) (Anchor 2006a) and the JDG responses to comments submitted on August 2, 2006. Information that relates directly to hydrodynamics and sediment transport issues within the Site was presented in Section 8 of the PSCR. It is included again below for completeness and for reference purposes.

The physical characteristics of the upstream portion of the Site are significantly different from the downstream portion. The upstream area from approximately Station 80 to Station 102 (Figure 1) is characterized by discharge from concrete culverts, gunite-lined side slopes with earthen bottom, and steeper hydraulic gradients, as compared to downstream areas, which are characterized by natural and armored banks and a low hydraulic gradient.

Sediment thickness is relatively thin in the upstream reach and the concentrations of several contaminants of potential concern (COPCs) are observed to vary in space and with time, indicating the apparent effects of sediment resuspension, transport, and deposition during storm events. Based on data collected by others, there also appears to be a significant historical source of upstream contamination for some COPC, especially polynuclear aromatic hydrocarbons (PAHs).

The middle portion of the Site, from the end of the gunite-lined channel to the islands (approximately Station 25 to Station 102 – Figure 1), is characterized by thicker sequences of soft sediments. The sediment thickness in this portion appears to be controlled by physical hydraulic factors, such as channel morphology (e.g., depth and width) and structures (e.g., bridges and outfalls). The concentrations of several COPCs appear to change in space and with time in this reach also, again indicating the apparent effects of resuspension, transport, and deposition of sediments during storm events.

The lower portion of the Site (Station 0 through Station 25 – Figure 1) is characterized by a more defined hydraulic channel, and a thick (up to 12 feet) sequence of soft sediments on the northern bank, indicating it is a significant sediment depositional area.

Benthic toxicity and benthic assemblage investigations by the Total Maximum Daily Load (TMDL) Lead Organization (Parsons et al., 2002; 2004) showed that both sediment toxicity and benthic assemblages varied with space and through time. These data and observations are consistent with the documented observations of chemical, physical (grain size), and salinity changes seen throughout the Site. All of these data together indicate that the sediment surface at the Site is dynamic; it likely changes on a regular basis as a result of variable flow conditions caused by natural hydrologic events. These observations indicate that a detailed understanding of the hydraulic conditions and natural fluctuations at the Site is important for the following reasons:

- The Site hydrology likely controls the current distribution of shallow COPCs. Most of the preliminary COPCs at the Site have an affinity for finer-grained sediments that have a high total organic carbon content. These types of sediment will preferentially accumulate in depositional areas identified in the soft sediment

thickness survey completed by Anchor in 2005 and discussed in the PSCR in Section 2.3.1.

- The Site hydrology will have a strong influence on the potential for sediment transport through the system in both current and post-remedy conditions. Although depositional, scour, and transport areas can be identified on a conceptual basis, a more detailed analytical or numerical understanding of bed stability will be required to gain an understanding of COPC physical transport and causal relationships on bed stability under different scenarios (e.g., hydraulic modification, natural sedimentation and capping, source removal, and natural recovery) in the feasibility analyses.

An initial upstream source evaluation is relevant at this time in the RI because it will provide information regarding potential ongoing point sources or ambient levels of potential contamination from runoff outside of the Site boundaries. Concentrations of several samples from areas outside of the Site boundary South of Highway 225 have had high concentrations of PAHs in past sampling events. In addition, this evaluation may provide information relevant to understanding why the distributions of some COPC have tended to vary over space and time at the Site.

Previous studies at Patrick Bayou have focused on the distribution of COPCs in surface sediments. It is important to begin to define the vertical extent of contamination as part of the source evaluation and in developing an understanding the historical record of contamination. The vertical delineation will also provide data to estimate the volume of potentially contaminated materials in future Feasibility Study (FS) related tasks.

2 SAMPLING DESIGN AND RATIONALE

2.1 Hydrodynamic Data

2.1.1 Objectives and Rationale

The overall objective of this task is to further develop the Conceptual Site Model (CSM) for sediment transport at the Site. This CSM will be developed to provide a qualitative description of the primary processes affecting sediment transport and bed stability in the system. In addition, the CSM will be used to achieve the following primary objectives of the proposed task:

- Evaluate the effect of high-flow events on bed stability, which includes determining areas of potential scour and depth of scour in those areas.
- Evaluate the fate of eroded sediment during high-flow events.
- Use study results to guide the design of potential future field studies.

Secondary objectives related to the data collection efforts of this task are:

- Provide information on salinity, temperature, dissolved oxygen (DO), and tidal patterns to describe conditions that may affect the distribution of habitat and ecological receptors.
- Provide information that may be useful for future work related to the FS (e.g., predicted current velocity or bed shear stress values for cap design).

A phased approach to the hydrodynamic study and analyses will be utilized and will provide an efficient and cost-effective method for achieving the project goals. Three phases may be required to complete the Site sediment transport study. Phases 1 and 2 are described in this Work Package. The details of Phase 3, which involves detailed sediment transport modeling, would be described in a future document if it is determined that additional work is needed beyond Phases 1 and 2 to achieve the task objectives discussed above.

A decision point will be reached at the end of each phase that will include a review of the work conducted during that phase. The decision point will address the following questions:

- Have the overall study objectives been achieved? If the answer is no, then proceed to the next phase of the study.

- Based on the results of this phase, should the technical approach to the next phase be modified?

2.1.1.1 Overview of Phase I

Work conducted during Phase 1 of the study consists of five primary tasks:

1. Analysis of available data related to sediment transport
2. Hydrologic analysis of rare/significant rainfall events
3. Hydrodynamic analysis of high-flow events
4. Collection of data for calibration of the hydrologic and hydrodynamic models
5. Development of provisional CSM for sediment transport

2.1.1.1.1 Analysis of Available Data

Available data, either collected to support the RI study or historical information, will be compiled and analyzed. Data that are related to sediment transport at the Site includes: sediment bed thickness, grain size distribution, bathymetric measurements, bed chemical concentrations (COPCs), and flow data for permitted outfalls. Graphical and statistical analyses of these data will be used to gain insights about sediment transport processes in the study area.

2.1.1.1.2 Modeling Components and Linkage

The modeling framework in Phase 1 consists of a series of hydrologic models that are linked to a hydrodynamic model, which will be used to evaluate the potential for bed scour during high-flow events at the Site. The first step in the analysis will be to analyze historical precipitation data for the region surrounding the study area so as to determine the magnitude and duration of rare/significant rainfall events (i.e., events with return periods ranging from 2 to 100 years). The results of this analysis will be used as input to the hydrologic models, which will be used to predict the freshwater inflows due to runoff to the Site for a specific rainfall event. The inflows predicted by the hydrologic models will be used as input to the hydrodynamic model, as discussed below. A schematic of the overall linkage between the models is provided in Figure 2.

A critical component of the sediment stability analysis is estimation of the freshwater inflow to the Site during high-flow events. Minimal data are available for inflow during storms, which necessitates the development and application of a hydrologic runoff model. Many runoff models are available for application to the Site watershed, ranging from simple spreadsheet models that incorporate rainfall, land-surface conditions, and Best Management Practices (BMP) to complex long-term or storm-event models that require extensive site-specific data (e.g., HSPF, SWAT, AGNPS, and SWMM). For the Site, a spreadsheet model will be used initially during this phase, which is appropriate for the available site-specific data and the study requirements.

The Site watershed can be separated into three hydrologic sub-basins:

- The sub-basin located to the south of Highway 225 (which is hydraulically separated from the rest of the watershed)
- The sub-basin draining into the East Fork (which is primarily agricultural land use)
- The remaining watershed that drains into the bayou north of Highway 225 (which contains primarily urban/industrial land uses)

The three sub-basins will be modeled separately because each sub-basin has unique hydrologic characteristics and behavior. A curve number method (developed by the National Resource Conservation Service [NRCS]; USDA 1986) will be used to estimate runoff from the sub-basins located south of Highway 225 and draining into the East Fork. For the area to the north of Highway 225, a method that is more appropriate for developed land, which includes using runoff coefficients (Pilgrim and Cordery 1992), will be used. The hydrologic models use precipitation as input, along with land-surface-based parameters and soil properties that translate rainfall into runoff.

The hydrologic model will consist of three relatively independent “box” models that will quantify runoff from the East Fork, South of Highway 225, and North of Highway 225 sub-basins. Current land use information will be obtained from the Houston-Galveston Area Council (HGAC; circa 2002; [---

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and Contaminant Source Evaluation](http://www.h-</p></div><div data-bbox=)

gac.com/HGAC/Programs/Clean+Rivers/Landcover.htm) and imported into a Geographic Information System (GIS). Based on previous experience in the Houston, Texas area, HGAC is the most relevant source of land use information in this area. Information from HGAC will be reviewed to ensure it is representative of current conditions. This information, along with the watershed topography and stream/channel network, will be used to delineate the three sub-basins of the watershed and set the percentage cover for each land use (e.g., agriculture, residential, commercial, or industrial) within each sub-basin. Once each sub-basin is delineated, curve numbers for the East Fork and South of Highway 225 sub-basins and runoff coefficients for the North of Highway 225 sub-basin will be specified for each land cover type based on literature values found in: USGS (1986), Pilgrim and Cordery (1992), and other studies relevant to the area (Baird et al. 1996; Benaman 1996; Newell et al. 1992). The “design storms” that will be determined from statistical analyses of local precipitation data will be used as the primary input for each hydrologic model. Thus, the primary result of a model simulation will be an estimate of the freshwater inflow into the Site due to runoff that resulted from a given storm (e.g., 100-year rainfall event).

A hydrodynamic modeling analysis will be used to evaluate the potential for bed scour during high-flow events at the Site. The results of this analysis will be used to: 1) evaluate spatial distributions of bottom shear stress for floods with return periods ranging from 2 to 100 years; and 2) infer potential effects of floods on bed scour. The hydrodynamic model that will be applied in this study is the Environmental Fluid Dynamics Code (EFDC), which has been successfully applied in a number of U.S. Environmental Protection Agency (USEPA) studies at other sites, including studies for USEPA Region 6. The model will be used in two-dimensional, vertically-averaged mode, which is a valid approach for simulating high-flow events at the Site. A three-dimensional model is not necessary because the effects of density-driven circulation, due to mixing of freshwater and saltwater, on hydrodynamics in the bayou during high-flow events is minimal relative to the fresh water inflow, which would be expected to control scour and deposition of sediments during these events. It is anticipated

that a boundary-fitted curvilinear numerical grid will be developed for the model domain, which will extend from the box-culvert outlets (upstream boundary) to the mouth of the bayou at the HSC (downstream boundary). Resolution of the numerical grid will be sufficient to resolve all important physical features in the bayou. Tidal effects will be incorporated into the simulations. In addition, the effects of flooding and drying of intertidal areas in the bayou will be included in the model. Information from a bathymetric survey conducted in June of 2005 will be used to develop model inputs for the geometry and bathymetry of the bayou.

The model will be used to simulate flow at the Site for high-flow events with return periods of 2, 5, 10, 20, and 100 years. Freshwater inflow to the Site during a high-flow event, which is an input to the hydrodynamic model, will be specified using the results of the hydrologic model discussed above. An analysis of tidal data for the HSC will be conducted to determine the appropriate temporal variations in tidal elevation at the mouth of Patrick Bayou (i.e., downstream boundary of the hydrodynamic model) during a high-flow event. The primary products of the high-flow simulations are predictions of the spatial distributions of current velocity and bottom shear stress at the Site. These spatial distributions will be used to estimate the locations of potential bed scour for a particular flood discharge. For example, a typical value for the critical shear stress for erosion of cohesive (muddy) sediment is 0.1 Pascal (Pa), which corresponds to a current velocity about 0.8 feet/second (ft/s). Thus, using this criterion, areas with predicted bottom shear stress greater than 0.1 Pa would be considered to have the potential for bed scour. The results of this analysis will be used to gain a qualitative understanding of the potential for bed scour at the Site during high-flow events.

2.1.1.1.3 Assessment of Modeling Uncertainty

The absence of hydrodynamic and hydrologic data to calibrate the models developed during Phase 1 introduces uncertainty into the high-flow-event simulations. For both models, the effects of this uncertainty on conclusions derived from the hydrodynamic modeling analysis will be minimized through

the use of bounding simulations. Critical parameters that affect model predictions (e.g., effective bottom roughness for the hydrodynamic model and curve numbers for the hydrologic model) will be varied between realistic upper- and lower-bound values, which are determined from previous experience on similar aquatic systems and watersheds. For each high-flow event (e.g., 100-year flood), two simulations will be conducted using the upper- and lower-bound values of model parameters. The results of the 100-year flood simulation (or any other high-flow event) will be expressed as a range, which represents upper- and lower-bound predictions of the model. Presumably, the “true” answer lies somewhere within the range of values predicted by the model. While uncertainty exists in the model predictions, due to lack of model calibration, this approach will quantify that uncertainty and provide a reliable approach for evaluating the effects of high-flow events on bed stability at the Site.

2.1.1.1.4 Development of Provisional CSM

The results of the analyses discussed above will be used to develop a provisional CSM for sediment transport at the Site. This CSM will provide a qualitative description of the important processes controlling sediment transport and bed stability at the Site. The CSM is provisional and will be modified as necessary during subsequent phases of the sediment transport/stability study.

2.1.1.2 Overview of Phase 2

Work conducted during Phase 2 of the study consists of four primary tasks:

- Refine design of Phase 2 based on Phase 1 results (as necessary)
- Calibrate the hydrologic and hydrodynamic models
- Re-evaluate the high-flow simulations using the calibrated models
- Revise the provisional CSM as needed

2.1.1.2.1 Model Calibration

The primary goal of this phase is to reduce the uncertainty in the model predictions, and therefore increase the reliability of study conclusions, through calibration of the hydrologic and hydrodynamic models developed during Phase 1. Model calibration consists of the adjustment of various parameters such that

the agreement between observed and predicted values is optimized. For example, the curve numbers used in the hydrologic model can be adjusted so that the agreement between simulated and measured flow rate due to runoff is optimized. In a similar way, the hydrodynamic model will be calibrated by adjusting the effective bottom roughness (which affects the frictional or drag force exerted on moving water by the sediment bed) so that differences between predicted and measured stage height (water surface elevation) and current velocity are minimized. The calibration process will yield site-specific values for the model parameters.

Data collected during the field studies described in Section 2.1.2 below will be used to calibrate the hydrologic and hydrodynamic models. It is anticipated that data will be collected during three high-flow events, and those data will be used to calibrate both models. For the hydrologic model calibration, rainfall data from the precipitation gauge located closest to the Site will be obtained from the Harris County Department of Homeland Security and Emergency Management (HCOEM) (<http://www.hcoem.org/>) for the time period of the field study. These data will be used as the forcing function (i.e., precipitation input) to the hydrologic model. Flow rates measured at sampling locations PB075 and EF005 (Figure 3) during the high-flow events will be compared to predicted flow rates due to watershed runoff in order to calibrate the hydrologic model.

The freshwater inflows to the Site during the high-flow events, as predicted by the calibrated hydrologic model, will be used as inputs to the hydrodynamic model for the calibration simulations. Tidal data collected in the HSC during the period when the high-flow events occurred will be used as the tidal conditions at the downstream boundary of the hydrodynamic model. The model will be calibrated through comparisons of measured and predicted current velocity and stage height at sampling locations PB045 and PB020 (Figure 3) located within the Site.

Model performance during the calibration period will be evaluated using various methods. Qualitative assessments of model-to-data comparisons will be

performed, which include temporal plots of predicted and measured quantities (i.e., flow rate, current velocity, and stage height) at each sampling location. Other model performance measures that will be investigated for the hydrodynamic and hydrologic models include relative error (i.e., percent difference), correlation coefficients (i.e., R^2), and Nash-Sutcliffe measures (ASCE 1993). In addition, if possible, flow frequency curves for the measured and predicted flow rates will be compared to determine if the intensity and timing of a high-flow event is captured by the hydrologic model.

2.1.1.2.2 Model Calibration and CSM Revision

After calibration of the hydrologic and hydrodynamic is completed, the high-flow simulations conducted during Phase 1 will be repeated using the parameter values determined during the calibration process. Model results will be updated using the calibrated models. The provisional CSM will be refined as needed, based on the updated results.

2.1.2 Sample Design

Field-collected data will be used to support the model calibration in Phase 2 described in Section 2.1.1.2.1. The sample design to collect the necessary data is described in this section. Table 1 summarizes the sample design for this task. It should be noted that station identifiers were developed based on location and distance from the downstream terminus of the water body. For example, PB26 indicates the station is located within the Site, 2,600 feet upstream of the Site boundary with the HSC. Station identifiers that begin with EF indicate the sample station is in the East Fork tributary.

2.1.2.1 Objectives of Field Study

The objectives of the field study for this task are:

- Collect hydrodynamic and sediment transport data during three high-flow events related to significant rainfall (see Section 2.1.2.4.1)
- Collect continuous measurements of surface water temperature, conductivity, elevation, and DO for a period of 12 months

2.1.2.2 *Sample Locations*

Five data collection platforms (DCP) will be established to collect data at the locations in Figure 3. The precise location of these DCPs will be determined in the field based on site conditions and will be established to best collect the necessary data and take advantage of available structures or site features (e.g., bridges).

2.1.2.3 *Data Collection*

The following data will be collected during the field study for this task:

- Water surface elevation (WSE)/stage height and water velocity – This data will be collected at Stations EF005, PB075, PB045, and PB020. Water surface elevation and velocity data will be used to calibrate/validate the hydrodynamic model. In addition, discharge will be calculated using the WSE and velocity data at Stations PB075 and EF005. This information will be used to describe the flow of water from the East Fork and upstream reaches of Patrick Bayou into the Site. In addition, WSE will be collected to achieve the secondary objective of describing the range of tidal conditions within the Site.
- Total suspended solids (TSS) – This data will be collected at Stations EF005, PB075, and PB012 to calibrate/validate the sediment transport model.
- Conductivity, temperature, and DO – This data will be collected at Stations EF005, PB075, PB045, and PB026 to achieve the secondary objective of describing the range of salinity and DO conditions within the Site.

2.1.2.4 *Sample Frequency and Data Collection Periods*

2.1.2.4.1 *Hydrodynamic and Sediment Transport Model*

The initial data collection period will continue until three high-flow events defined in this section have occurred. It is expected that this period will extend for approximately 1 month. Once data from these events has been processed and data quality has been verified, collection of TSS samples will be discontinued. Hydrodynamic and water quality (velocity, depth, conductivity, temperature, and DO) data collection will continue for an additional period, until a 12-month data collection period has occurred. The primary purpose of the 12-month data

collection period is to obtain seasonal information on hydrodynamic and water quality parameters.

Velocity and WSE data will be collected every 15 minutes during the initial data collection period. TSS composite samples will be collected using an autosampler (e.g., Teledyne Isco, Inc. [ISCO] Portable Sampler) continuously on a 3-hour cycle (one composite every 3 hours; totaling eight per day). The autosampler will be serviced every 3 days and the sample bottles collected and handled in accordance with the field activities and methods in Section 4. Collected samples for TSS will be analyzed according to the following schedule:

1. If no rain occurred (based on the closest HCOEM precipitation station), then the 12th sample collected in the series will be analyzed to obtain a "baseline" TSS measurement for those 3 days.
2. If at least 0.1 inch of total continuous rain occurred during the 3-day period (based on the closest HCOEM precipitation station), then the precipitation record will be analyzed and samples that were collected during the rainfall event (i.e., rainfall greater than 0 inches) will be sent for TSS analysis. In addition, the sample collected immediately before the onset of rainfall and all samples collected up to 12 hours after the rainfall event will be sent for TSS analysis.

If the required number of rainfall events has not occurred during the data collection period, the data collection period will be extended until the desired number of events has occurred. If the magnitude of rainfall events during the data collection period does not reflect a suitable range of conditions (as determined by the project technical team) or if baseline conditions are not re-established between events to sufficiently identify distinct events for model calibration/verification, the data collection period may be extended on a bi-weekly basis.

Initially, a 2-week pilot data collection period will be completed to start the investigation. The purpose of this pilot collection period will be to allow for any adjustments to the sample approach and verify proper instrument performance.

2.1.2.4.2 Conductivity, Temperature, Dissolved Oxygen, and WSE

Data will be collected continuously during a 12-month period. Measurements will be taken continuously at 1-hour intervals. The only exception will be during the hydrodynamic model data collection period when measurements will be taken every 15 minutes.

Additional information on the field activities and data acquisition for this task are included in Sections 4 and 5.

2.2 Upstream Source Characterization Data

2.2.1 Objectives and Rationale

The objective of this task is to provide an initial evaluation of the potential for upstream sources of COPCs to provide long-term contaminant loading risks to the Site. As detailed in the Site PSCR (Anchor 2006a), land use in the watershed upstream of the Site is mixed residential, pasture, agricultural, and commercial. Because many of the upstream portions of Patrick Bayou are concrete-lined open drainage ditches, chemicals in surface water and soil runoff from these areas would quickly reach the Site under high flow conditions.

Historical sediment quality data from the Site investigations by the TMDL Lead Organization, USEPA, and Texas Natural Resource Conservation Commission (TNRCC) showed high concentrations of PAHs and metals in particular were present at sampling stations just south of the Highway 225 underpass. PCB Aroclors and mercury were also detected in upstream sediments. However, the distribution of other COPC at the Site, including, hexachlorobenze (HCB), hexachlorobutadiene, and dioxins/furans have the lowest concentrations of these COPCs in the upstream areas and the East Fork (see Figures 3-2 through 3-9 of the Site PSCR; Anchor 2006a). These results indicate there is not a high potential for ongoing sources of upstream contamination for these particular COPCs (i.e., HCB, dioxins); therefore, they are not included in the proposed source evaluation sampling design.

Other potential COPCs typically associated with urban runoff include pesticides. The distribution of pesticides at the Site was not evaluated in the PSCR; however, they were identified by TCEQ in comments on the PSCR as being a contaminant of concern because of observed concentrations in historical samples. Because of the historical data on pesticides at the Site and their ubiquitous nature in urban environments, they are included in the proposed source evaluation sampling design.

Point sources for contaminants may include historic and ongoing direct industrial and municipal discharges and stormwater discharges. Nonpoint sources include overland stormwater runoff from roadways, industrial, commercial, highway, rail and residential areas located adjacent to Patrick Bayou, as well as agricultural and pasture sources. Other sources include spills, erosion, and transport of upland soils, infiltration of liquids, and leaching from surface or subsurface soil impacts. Chemicals may be transported in surface water as suspended particulates and dissolved constituents. Chemicals in surface water may originate from upstream sources, direct discharge or release within the Site, deposition from the air, groundwater, or resuspension of sediment. Suspended particulates are likely to settle out in quiescent areas of the Site. Dissolved constituents generally remain in the water column except where chemical or biological processes cause precipitation or adsorption. Volatilization and photolysis may also transform some chemicals in the upper portion of the water column.

The COPCs for the Site are generally hydrophobic compounds that preferentially partition into sediments and organic matter. The sample design assumes that existing sediment accumulations found in the bottoms of upstream drainages are representative of materials that are transported to the Site during high flow events associated with runoff during rain storms in the area. This approach will provide a valid initial evaluation of the potential importance of ongoing upstream contamination issues to the Site. Depending on the results of this initial evaluation, more complex sampling strategies that consider surface water and suspended sediment sampling may be required in the future.

2.2.2 Sample Design

A judgmental, adaptive sampling design will be used to characterize potential upstream sources. Sediments in the system of upstream tributaries, drainage networks, and ditches carrying runoff, stormwater, and point-source discharges into Patrick Bayou will be sampled for bulk sediment chemistry. This network of drainage pathways will be identified using available maps and GIS resources and verified during a field reconnaissance survey. Based on the combined results of the maps and field survey, sample locations will be identified. The strategy for identifying sample locations will include confirmatory sampling at four historical locations in Patrick Bayou (n=3) and the East Fork (n=1) identified in Figure 4. Resampling at these locations will provide some information regarding potential ongoing sources and trends over time. Subsequent sample locations will be identified by sampling just below the convergence of drainage pathways or outfalls along the main drainage pathways. Additional sample locations will be identified for secondary drainage pathways in a similar fashion and will continue upgradient. Using this approach, sample locations will be identified for up to 20 locations within the watershed. Professional judgment will be applied when identifying sample locations. All sample locations will be recorded per the survey requirements in Section 4.5.

For each sample location, surface sediment (0-2 centimeters [cm]) will be collected for bulk sediment chemistry analysis of the parameters identified in Section 2.2.1 and listed in Table 2. Due to the potentially transient nature of sediments in some of the drainage pathways, sample locations may be adjusted in the field to target available sediments at the time of collection.

2.3 Vertical Profiling

2.3.1 Objectives and Rationale

Determination of the vertical distribution of COPCs within Patrick Bayou is a key component of the overall remedial investigation of the Site. Results of vertical characterization of the sediments within the Site will be used in part to determine the volumes of potentially contaminated sediments in the FS.

Previous investigations within the Site focused on chemical data for surface sediments, and there is no existing information concerning the vertical distribution of COPC. Developing an understanding of the vertical distribution of COPC is important for several reasons, including the following:

- Vertical characterization will help determine if sources of COPCs are primarily associated with historical discharges, or if there are significant ongoing sources. If COPCs are primarily related to historical discharges, one would expect the largest mass of those constituents to be associated with deeper sediments.
- Vertical characterization will help focus RI and FS evaluations on those areas that pose the greatest short-term and long-term risks for contaminated sediment exposure and transport. For example, if thick sequences of contaminated sediments are identified that require some type of remedial/management action to eliminate a complete exposure pathway, then it is important to know the chemistry of these materials.

The data collected in the vertical characterization process for Site sediments will also be able to be used to evaluate if parts of the system have the ability to recover naturally through mixing and covering by fresh sediments entering the system. This type of recovery is typically monitored over a period of time and the process is referred to as Monitored Natural Recovery (MNR).

The historical record of contamination within the Site will be evaluated using detailed analyses of sediment cores for the presence of radioisotopes that can be used to estimate sediment deposition rates. Cores will be sectioned into appropriate depth intervals for analysis of both COPCs and the radioisotope of Cesium-137. Gamma spectral analysis for the presence of this radioisotope may allow estimation of the age of the materials in each interval, so that a historical record of COPC concentrations and placement can be constructed. Additionally, the cores may provide data that allow for the estimation of historical and recent sedimentation rates and sediment quality. This type of information is developed based on the accumulated sediment thickness above marker horizons identified in the Cesium-137 data.

In addition to the vertical sediment profiling, historical aerial photographs will be collected and analyzed to develop a better understanding of changes that have occurred at the Site with regard to site hydrology and sediment deposition. This evaluation will focus on identifying significant changes in channel morphology and structures that may have influenced the sediment transport and depositional characteristics of the Site through time.

2.3.2 Sample Design

Field collected data will be used to characterize the quality of sediments at the Site both in the vertical and horizontal dimensions, and the historical record of sediment deposition. The sample design to collect the necessary data is described in this section. Table 3 summarizes the sample design for this task.

2.3.2.1 Field Study Objectives

The field study objectives for this task are:

- Collect sediment cores to characterize historical sediment quality and deposition rates
- Collect sediment surface grabs to characterize sediment quality in more recently deposited sediment

2.3.2.2 Sample Locations and Intervals

A total of 17 locations at the Site are included in the sample design. Station locations were identified using a judgmental approach biased primarily toward locations with thick, soft sediment layers; these locations will likely provide the best historical record of sedimentation. The current understanding of soft sediment thicknesses is based on the push probe survey conducted by Gahagan & Bryant Associates, Inc. (GBA), in June 2005 on behalf of the Patrick Bayou JDG. The results of this survey were presented in the Patrick Bayou Preliminary Site Characterization Report (PSCR) (Anchor 2006a). For comparison purposes, and to provide a comprehensive characterization of sediment quality, locations were selected within areas that have relatively thin layers of soft sediments as well. Sample locations are identified in Figure 5 and cross-sections that show the profile of the Bayou and soft sediment thickness are provided in Appendix A.

Sediment cores will be collected and sampled for bulk sediment chemistry at all 17 locations identified in Figure 5. Sediment cores at a subset of six locations (shown on Figure 5) will be sampled for radiochemistry. Co-located sediment surface grabs will be collected and sampled for sediment chemistry analysis at all 17 locations.

The cores will be collected using a 3-inch piston core that has a maximum penetration/recovery depth of approximately 8 feet. All cores will be manually pushed to the full length of the core, or until refusal, whichever occurs first. Core intervals for bulk sediment chemistry and radiochemistry will be collected over the following intervals:

- Chemistry – The surface interval, which will include the biologically active layer, will be 0 to 11 cm (0 to 0.36 feet). Subsequent intervals will be approximately 30 cm. Sediment surface grabs will be sampled over the 0 to 2 cm interval for bulk sediment chemistry to evaluate the chemistry of very recent sediments.
- Radioisotope analysis – Cores will be subsampled in consecutive 4 cm intervals (0 to 4 cm, 4 to 8 cm, 8 to 12 cm, etc.). Approximately every eighth interval, starting with the 0 to 4 cm interval, will be included in the initial radioisotope analysis; remaining intervals will be sampled and archived for subsequent analysis if needed. Based on the result of the initial analysis, an additional seven intervals may be selected from the remaining samples for radioisotope analysis. This sampling design may be modified in the field for cores that have a low penetration before reaching refusal.

2.3.2.3 *Parameters for Analysis*

Samples collected during this task will be submitted to an analytical laboratory for analysis according to the sample design summary provided in Table 3. In general, all samples collected for bulk sediment chemistry will be submitted to the analytical laboratory for the comprehensive list of parameters in Table 4. Only selected intervals identified in Table 3 will be submitted for radiochemistry; the remaining samples will be archived for possible analysis as described above.

For the purposes of vertical characterization of PCBs in sediment, PCB Aroclors will be analyzed in bulk sediment at multiple depth intervals. PCB congener analysis will be performed on sediments collected from the biologically active layer (0 to 11 cm). PCB congener analysis of this layer will provide information that will support the risk assessment process and focus any subsequent sampling efforts to characterize surface sediments at the Site. This design limits costly PCB congener analyses, but still provides adequate data for future risk assessment and Site characterization. The design also includes analysis of dioxins and furans at every other sampling station (shown in Table 3) to limit analytical costs.

3 LABORATORY ANALYTICAL METHODS, QUALITY CONTROL, AND MEASUREMENT QUALITY OBJECTIVES

Analytical methods and the associated method reporting limits for sediment samples collected as part of this Work Package are listed in Table 4. For comparison purposes, sediment quality guideline values (Effect Range-Low [ERL] and Total Equivalency Levels [TEL]) from the National Oceanic and Atmospheric Administration (NOAA) Quick Reference Table (SQuiRT; Buchanan 1999) are included.

A summary of laboratory quality control samples and frequency of analysis for this Work Package are listed in Table 5.

Laboratory measurement quality objectives for precision, accuracy, and completeness of sediment chemistry analysis for this Work Package are listed in Table 6.

4 FIELD ACTIVITY METHODS AND PROCEDURES

4.1 Project Organization, Schedule, and Contacts

A comprehensive description of the project organization, schedule, and contacts is provided in the Quality Assurance Project Plan (QAPP) (submitted as part of the RI Work Plan; Anchor 2006b).

4.2 Access and Sampling Permission

Anchor Environmental, L.L.C. (Anchor), will identify access and permit requirements prior to field crew mobilization. Anchor will coordinate with individual private property owners concerning specific sampling dates once access agreements have been executed.

The Site will be accessed through four privately owned facilities: Shell Oil – Deer Park Refining Services, Shell Chemical L.P. – Deer Park Chemical Plant, Lubrizol Corporation, and OxyVinyls L.P. The following personnel are facility-specific points of contact (POC) that will oversee the field activities occurring at their respective facilities:

- Joe Phillips – Shell Oil - Deer Park Refining Services (primary contact)
- Jeff Stevenson– Shell Chemical - Deer Park Chemical Plant (backup for Shell Oil)
- Norman Mollard – Lubrizol Corporation
- Jeff Adamski – OxyVinyls L.P.

4.3 Utility Clearances

The nature of sampling activities is unlikely to create a hazard due to underground utilities or submerged pipelines; however, intrusive subsurface sampling activities will not be performed near any known or observable structures. Due to the industrial nature of the Site, it is not anticipated that any residential underground utilities will exist at the proposed sampling sites. Location of underground utilities will be coordinated with industrial facilities located along the site boundaries. If underground or submerged utilities are present at a specific sampling location, the sampling location will be moved to avoid the utility.

4.4 Equipment, Supplies, and Sampling Containers

The analytical laboratory will provide certified, pre-cleaned, USEPA-approved containers for all samples. Prior to shipping, the analytical laboratory will add preservative, where

required, according to USEPA protocols. Sample containers for bulk sediment chemistry and radiochemistry are described in Table 7.

Necessary equipment, supplies, and sampling containers will be shipped or carried to the Site. Equipment and supplies may be shipped directly to the field from the vendor or to the Gulf Coast office of Anchor for inspection prior to deployment or use in the field at the Site. All equipment and supplies will be inspected and tested as needed prior to field use.

4.5 Surveying

Horizontal positioning at each sampling location will be determined using a differential global positioning system (DGPS) with a handheld global positioning system (GPS) unit as backup if necessary. Station positions will be recorded in latitude and longitude to the nearest 0.01 second in the North American Datum 1983 (NAD 83). The accuracy of the horizontal coordinates will be within 3 meters.

The project vertical datum for determining orthometric heights is the North American Vertical Datum of 1988 (NAVD88). Mudline elevation of each sampling station will be determined relative to NAVD88 by measuring the water depth with a calibrated fathometer or lead line and subtracting the tidal elevation. Tidal elevations will be determined using water surface elevations collected as part of the hydrodynamic sampling task or from the Texas Coastal Ocean Observation Network (TCOON) tide gage located on the HSC at San Jacinto State Park. If the TCOON gage is used, mudline elevations will be reported relative to mean lower low water (MLLW).

Station locations and data collection platform locations for this Work Package are summarized in Table 8.

4.6 Sampling Procedures

4.6.1 Sediment Collection Procedures

4.6.1.1 Cores

Sediment samples will be collected using a piston-coring device. Sediment core sample depths will be manually driven from the surface of the sediment to the full

length of the core, or until refusal, whichever comes first. Due to the design of the piston coring device, core target depths will not exceed 244 cm (8.0 feet).

Prior to sampling, the core tubes will be decontaminated according to the procedures outlined in Section 4.9. Care will be taken during sampling to avoid contact of the sample tube with potentially contaminated surfaces. Extra sample tubes will be available during sample operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used. During deployment and retrieval of the coring device, care will be taken to ensure that the end of the core tube does not become contaminated. When retrieved, each core will be inspected and a physical description of the material at the bottom of the core will be recorded.

Sediment cores will be inspected after they are secured on board the sampling vessel. Cores will be evaluated for acceptability using the following criteria:

- The sediment surface is relatively undisturbed
- The piston corer was not inserted at angle or tilted upon retrieval based on a visual inspection of the coring unit
- At least 80 percent core recovery versus penetration is achieved

If a core fails to meet any of the above criteria, it will be rejected and the sediment will be placed back into the sampling area after acceptable sediments are retrieved. Sediment cores that meet the above stated criteria will be processed as described below.

Sample collection activities will proceed from the most downstream location and proceed upstream to minimize any potential for sample interference caused by disturbed sediment.

4.6.1.2 Surface Grabs

Surface sediment samples will be collected using a stainless steel scoop, van Veen sampler (or similar), or a piston corer. Techniques will be selected based on water and sediment depths at the sampling locations.

For samples collected using a van Veen grab sampler or similar device, the grab sampler will be deployed and retrieved at a rate of approximately 1 ft/s to minimize contacting the bottom at an angle and potential disturbance of the sediment surface within the sampler.

Following the retrieval of the grab, it will be braced in an upright position. The flaps will be opened and the overlying water will be slowly removed using a siphon. If excessive water leakage is indicated by the lack of an overlying water layer, the sample will be rejected. Each grab sample will be visually characterized using the following additional criteria to determine if the sample is acceptable:

- Sediment is not leaking through flaps
- Sediment surface appears to be relatively undisturbed (i.e., minimal winnowing)

Samples that do not meet any one of the above criteria will be rejected, and the sample will be recollected. Corrective actions that may be used in the field to address constant overfilling or under-penetration of the grab include removal or addition of weights to the grab sampler or adding weights or buoys to the sampler.

Sample collection activities will proceed from the most downstream location and proceed upstream to minimize any potential for sample interference caused by disturbed sediment. It is expected that the radiometric data will be less sensitive to surface disturbances that result from coring activities; therefore, the bulk chemistry cores and grab samples will be collected prior to retrieving radiometric cores.

4.6.2 Sediment Processing

Sediment cores and surface grabs will be processed and placed in sample containers as soon as possible after collection (ideally within 24 hours of collection). Prior to processing, sediment cores will be stored upright and kept at 4° C if processing will not occur immediately.

All working surfaces and instruments used in the processing area will be thoroughly cleaned, decontaminated, and covered with aluminum foil to minimize outside contamination between sampling events (see Section 4.9). Disposable gloves will be discarded after processing each station and replaced prior to handling decontaminated instruments or work surfaces.

Sample containers will be kept in packaging as received from the analytical laboratory until use; a sample container will be withdrawn only when a sample is to be collected and will be returned to a cooler containing completed samples. Table 7 indicates holding times and preservatives.

The samples will be processed as follows:

- VOC samples will be collected immediately upon core extrusion by taking small subsamples over the length of each interval and placing them in a 2-ounce glass jar and capping the jar so there is minimal head space. It is expected that pore spaces within the sediments will be saturated so volatilization in the jar should be negligible.
- Record the description of the core on the appropriate log form as described in Section 5.1
- Using a decontaminated stainless steel or high-density polyethylene (HDPE) spoon, place sample material from the sampling device into a cleaned stainless steel bowl or HDPE bucket. If non-aqueous phase liquid or similar material (e.g., tar) is observed on the core tube or sample device, care should be taken not to sample sediment that is in contact with the tube or sample device (e.g., van Veen).
- Samples will be homogenized in the field. Homogenization refers to the complete mixing of sediment to obtain consistency of physiochemical properties throughout the sample prior to using in analyses (USEPA 2001). Samples will be homogenized prior to placing in the sample containers. The general procedure will consist of:
 - Removing unrepresentative materials (twigs, shells, leaves, etc.) and documenting in the appropriate field log

- Quickly and efficiently mixing the sample to minimize alterations in particle-size distribution and bioavailability
- Stirring the sediment until textural, color, and moisture homogeneity is achieved
- Using a clean, stainless steel spoon, completely fill pre-labeled sample containers, as indicated in Table 7.
- Immediately after filling the sample containers with sediment, place the screw cap on the sample container and tighten.
- Thoroughly check all sample containers for proper identification, analysis type, and lid tightness.
- Pack each container carefully to prevent breakage and place inside of a cooler with ice for storage at the proper temperature (4°C for all samples).

4.7 Installation of Hydrodynamic Data Collection Platforms

Anchor will install five DCPs at the approximate locations shown in Figure 3. Existing structures, including bridges, pilings, and docks, will be used when they are located near the desired location and offer a suitable site for collection of the required data. If suitable structures are not present, Anchor will install DCPs in the firmest soil available, and where the DCP is least likely to be damaged.

A support pole shall be installed by driving a post driver to a depth that will provide solid support of the post. The support pole shall be vertically installed and will provide a stable location to affix a continuous data recorder and a known elevation marker. An appropriate DCP will be designed and installed to meet the site-specific needs. All DCPs will be marked with reflective signage and high visibility markings for safety purposes. All DCP material will be secured in a manner to deter and prevent tampering, vandalism, or theft. This may include the use of locking aluminum gage houses, locking well caps, and other devices as needed.

All DCPs will be surveyed by Anchor or its subcontractor. Elevation surveys are required to establish the correct datum for reporting surface water elevation. Thus, each support pole shall have a permanent elevation mark or nail on the side, which will be surveyed.

Survey notes and photos shall clearly document the mark used to establish the elevation. Data collected will be sufficient to allow verification of surveys.

4.7.1 Instrument Packages

The following parameters will be measured by the instrumentation installed:

- Depth (surface water elevation)
- Temperature and specific conductivity (salinity)
- DO
- Velocity
- TSS

The following instrumentation will be used to collect the parameters of interest:

- **Multi-parameter monitoring sonde** – This type of datasonde will measure temperature, specific conductivity, DO, and vented water level (depth). This instrument is capable of in-situ, long-term datalogging. Measurements will be taken at the point of deployment. It is expected that a YSI, Inc. 600 Optical Monitoring Sonde (OMS) series datasonde or similar will be deployed for data collection.
- **Acoustic Doppler current profiler (ADCP)** – These units use Doppler technology to measure the return frequency of an acoustic signal sent through the water to determine the water velocity. They also measure velocity at programmable distances from the sensor and provide an average velocity over the desired interval of the beam path. These instruments are capable of in-situ, long-term datalogging. It is expected that the Sontek/YSI Inc. Argonaut-SW ADCP unit or similar will be deployed for data collection.
- **Automatic water sampler** – These units are programmable to allow a range of sample routines and contain a series of sample bottles. Samples are collected at programmed intervals with composite sample bottle configurations. A Teledyne ISCO, Inc. Portable Sampler (Model 6712) or similar will be deployed for data collection.

4.7.2 Staff Gages

Staff gages will be installed adjacent to all DCPs equipped with instrumentation collecting depth data. Staff gages or independent survey marks are required to verify surface water elevation readings from the data collection instruments and to determine correction factors for continuous data, as needed. Staff gages will be graduated to hundredths of a foot. The staff gages will be surveyed according to the requirements in Section 4.7.3.

4.7.3 Elevation Surveys and Cross Sections

Location and elevational surveys will be required to establish the precise location of DCPs and to establish the preferred vertical datum for reporting surface water elevation. The project vertical datum for determining orthometric heights is the NAVD88.

Channel cross-sections will be required at locations where discharge is to be determined (Figure 3). Channel surveys will be conducted using sounding weights, fathometers, downward looking ADCP, standard surveying techniques, or a combination of these methods to produce an accurate channel cross-section to the preferred vertical and horizontal datum at the DCP.

4.8 Field Instrument Procedures

4.8.1 General Calibration and Operation

Typically, the accompanying operating manuals should provide detailed descriptions of equipment calibration, operation, and maintenance. Instruments provided by Anchor will provide documentation of annual certified laboratory calibration. During field calibration, the following general criteria will be considered:

- The instrument should be allowed to warm up prior to calibration as specified in the manual.
- Sensors should be field calibrated according to manual instructions at the beginning and end of each sampling day for short-term sampling events.
- If the instrument is suspect, sensor calibration should be checked immediately before redeploying.

- Routine maintenance and inspection of in situ instruments should follow the manufacturers' recommendations, and detailed records of maintenance activities should be kept for quality assurance purposes.

The following general procedures for operating in situ instruments have a direct influence on data quality and apply for most models:

- The sealing parts of all underwater connectors and housings should be cleaned and coated with silicone grease to ensure proper lubrication and watertight integrity.
- Cables should be inspected for nicks, cuts, abrasions, and other signs of physical damage, and repaired as needed, prior to deployment.
- Desiccant should be inspected and replaced as needed.
- Battery condition should be checked periodically.
- Sensors should be housed in a way to protect from direct impact but allow for unrestricted water flow around sensors.
- Optical surfaces should be cleaned with a detergent, rinsed, and dried prior to deployment.
- During deployment, vessel should maintain its position.
- Sensors should be deployed from a part of the vessel that is outside the immediate influence of the prop wash and other vessel contaminant sources (bilge pumps).
- Sensors should be rinsed with fresh water after each sampling event.
- External sensors should be covered for protection when not in use.
- Instruments should be safely secured when on deck.

4.8.2 Continuous Data Collection Instruments

4.8.2.1 Service and Download Frequency

This section describes service events for hydrodynamic collection instruments.

4.8.2.1.1 Multi-Parameter Monitoring Sondes and ADCP Units

For sufficient data collection and proper maintenance of the data collection equipment, the servicing and downloading of data will be performed at an interval of approximately 21 days during the data collection period. At no time

should the interval exceed 28 days due to instrument limitations, such as memory or battery life, in order to offset the potential for any data loss caused by malfunction, loss, damage, etc. After 3 months of significant data is collected and DCP maintenance is established, the service and download interval may be extended to 28 days upon recommendation of the Anchor Field Team Leader and approval of the Project Manager. At no time will the scheduled interval exceed 35 days.

4.8.2.1.2 Automatic Water Sampler

The service and download frequency of automatic water samplers collecting surface water samples for TSS analysis will not exceed 72 hours due to instrument limitations and holding times.

4.8.2.1.3 Contingency Planning

If site conditions dictate, the operational status of the DCPs will be checked and the hydrodynamic data collection instruments will be downloaded and maintenance performed before the scheduled service and download interval has passed. The Anchor Field Team Leader will be responsible for initiating contingency visits to the site. Natural conditions, such as hurricanes, flooding, or severe drought, may warrant a contingency site visit.

4.8.2.2 *Operation and Maintenance*

4.8.2.2.1 Operation

The operational goal for monitoring water quality is to obtain the most accurate and most complete record possible. The general operational categories include maintenance of the monitoring station and equipment, periodic verification of sensor calibration, troubleshooting of sensors and recording equipment, and thorough record keeping.

4.8.2.2.2 Water Quality Monitors

The standard protocol for operation of the continuous water-quality monitors is based on *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting* (USGS 2006) and is as follows:

1. Conduct site inspection
 - a. Record monitoring sonde readings, time, and conditions
 - b. With an independent field meter, record readings and time near the deployed monitor
2. Remove monitoring sonde
3. Clean sensors
4. Return monitoring sonde
 - a. Record monitoring sonde readings and time
 - b. Record readings near monitoring sonde using independent field meter
5. Remove monitoring sonde, rinse thoroughly, check calibration
 - a. Record calibration check values
 - b. Recalibrate if necessary (see Section 5.2.2)
6. Return monitoring instrument to monitoring location

4.8.2.2.3 Automatic Water Samplers

The ISCO sampler will require maintenance every 72 hours, or more frequently if desired. This maintenance will include:

- Checking power level; replace battery as appropriate
- Replacing bottle rack with new, clean rack of 24 bottles. Before removing the rack, place the lids on the bottles so the samples do not spill. Be careful not to catch the distributor arm against the bottles.
- Remove water from melted ice, and place fresh ice in the bottle rack containing filled sample containers
- Place ice in the new, empty bottle rack
- Perform a check of the suction line to ensure no kinks, clogs, or cracks have occurred
- Perform a check of the strainer (if present) to ensure it is not clogged

4.8.2.3 Maintenance

Maintenance generally is governed by the fouling rate of the sensors, and this rate varies by sensor type, environment, and season. The performance of temperature and specific conductance sensors tends to be less affected by fouling but still requires

routine maintenance to maintain normal function. In addition to fouling problems, physical disruptions (such as those caused by recording equipment malfunction, sedimentation, electrical disruption, debris, or vandalism) also may require additional site visits.

Maintenance functions at a water quality monitoring station include:

- Inspection of the site for signs of physical disruption
- Inspection of sensor(s) for fouling, corrosion, or damage
- Battery (or power) check
- Time check
- Routine sensor cleaning and servicing
- Calibration (if needed)
- Downloading of data

Specific maintenance requirements will depend on site-specific configuration and equipment. The manufacturer's instructions must be followed for each type of equipment. Standard operating procedures for calibration, maintenance, and download of the data collection instruments (monitoring equipment) will be developed and tested as necessary prior to the initiation of the data collection period.

The manufacturer's recommended cleaning procedures will be followed for multi-parameter sensor systems and automatic water samplers.

4.8.2.4 Field Calibration

Calibration is performed by using standards of known quality. All calibration equipment must be kept clean, stored in protective cases during transportation, and protected from extreme temperatures. Backup monitoring sondes or sensors will be used to replace water-quality monitors that fail calibration after troubleshooting steps have been applied.

4.8.2.5 Troubleshooting

A list of common problems likely to be encountered in the field when servicing monitors will be developed to assist in the troubleshooting process. When a

parameter cannot be calibrated with known standard solutions, the Field Supervisor will determine if the problem resides with the monitoring sensor or with the monitor itself and will make necessary corrections to ensure that the monitor is operational. The Anchor Field Supervisor will carry backup sensors and sondes, if possible, so that troubleshooting can be accomplished at the time of the service visit.

4.9 Decontamination

Sample collection equipment, containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sediment sample material must meet high standards of cleanliness. All equipment and instruments used that are in direct contact with the sediment collected for analysis will be made of glass, stainless steel, HDPE, or polytetrafluoroethylene (PTFE), and will be cleaned prior to each day's use and between sampling or handling. Decontamination of all items will follow USEPA protocols (1986). The decontamination procedure is as follows:

- Pre-wash rinse with tap water or site water
- Wash with solution of tap water and Alconox soap (brush)
- Rinse with tap water
- Rinse three times with distilled water
- Cover (no contact) all decontaminated items with aluminum foil
- Store in clean, closed container for next use

The Field Supervisor may elect to implement a hexane rinse if there are significant residues observed on field equipment after the above decontamination procedures are used.

4.10 Field Quality Assurance/Quality Control (QA/QC)

4.10.1 Field Quality Assurance Samples

Per the RI Work Plan QAPP (Anchor 2006b), field duplicates will be sampled and submitted for analysis at a frequency of 5 percent of samples submitted for bulk sediment chemistry, radiochemistry, and TSS. Temperature indicators will be included in each container for shipment of bulk sediment chemistry or TSS samples to the laboratory. Equipment rinsate blanks will only be necessary for equipment and containers used to collect TSS samples, and will be collected and submitted for analysis when samples collected during high flow events (Section 2.1) are submitted to the

laboratory. Trip blanks will not be required for any samples collected per this Work Package.

4.10.2 Performance Audits and Corrective Actions

Performance audits and corrective actions will be performed per the RI Work Plan QAPP (Section 16; Anchor 2006b)

4.11 Investigation Derived Waste Handling and Tracking

This section provides a waste management plan for handling investigation derived waste (IDW) associated with initial RIs at the Site.

IDW for this Work Package is expected to consist of:

- Excess sediment generated during sampling (cores and slurries)
- Excess surface water and porewater during sampling
- Personal protective equipment (PPE) and other solid waste
- Decontamination and rinse water

4.11.1 Sediment

Generation of some excess sample material is anticipated during collection of cores.

Whenever possible, core material will be returned to the environment by returning the sediment back to the collection site (Patrick Bayou).

Field sampling conditions (weather conditions or other unanticipated events, such as leaks or spills at adjacent industrial locations) may preclude safe disposal of excess material at the time of sampling. If needed, excess sediments and slurries will be retained and stored in lined 10-gallon buckets for later return to the environment at the Site.

If needed, sediments and slurries will be retained and stored in lined 50-gallon drum(s) for later disposal at an approved solid waste handling facility. Drums will be clearly marked as to contents. A log of collection dates and times, plus approximate volume of each sample, will be maintained to facilitate off-site disposal of the material as either non-hazardous or hazardous dredge spoil material.

4.11.2 Surface and Porewater

Generation of excess porewater and surface water is possible during collection of cores for depth-specific characterization and profiles of COPCs within the Site. During the collection of sediments, whenever possible, excess aqueous material will be returned directly to the Site. Porewater will be returned to the environment by retaining it during sampling in a tray or bucket, and then dumping it in to the waters surrounding the sample processing location. Dilution of COPCs by ambient waters should be sufficient to achieve non-hazardous levels or no appreciable increase in ambient COPCs.

If needed, excess porewater may be retained and stored in lined 10-gallon buckets for later return to the environment at the Site.

4.11.3 Decontamination and Rinse Water

Decontamination and rinse water will be retained in lined 10-gallon buckets, and disposed of via the municipal sewer system. Dilution of COPCs by flushing with tap water and the additional dilution of COPCs by other sources of flow in the municipal sewer system should be sufficient to achieve non-hazardous levels or no appreciable increase in ambient COPCs. If decontamination occurs within a private facility (e.g., Shell, OxyVinyls, or Lubrizol), IDW tracking and disposal procedures will be followed.

4.11.4 PPE and Solid Waste

PPE and solid waste will be decontaminated to the extent possible and disposed as municipal waste.

5 MEASUREMENT AND DATA ACQUISITION

5.1 Sediment Related Data

5.1.1 Field Documentation and Sample Identification

Field sample logs and notebooks will be maintained for all samples collected during the field program. All sample field notebooks will have numbered pages. All data entries will be made using indelible-ink pens. Corrections will be made by drawing a single line through the error, writing in the correct information, then dating and initialing the change.

At a minimum, the following information will be included in the log for sediment cores and surface grabs:

1. The sample station number
2. Location of each sample station as determined by DGPS
3. Date and collection time of each sediment sample
4. Names of field supervisor and person(s) collecting and logging the sample
5. The mudline depth as measured by a lead line or fathometer, converted to a mudline elevation using the tide heights provided by either the nearest NOAA tide gage or surveyed tide gage
6. Observations made during sample collection including: weather conditions, complications, ship traffic, and other details associated with the sampling effort
7. Length and recovery for each sediment core
8. Qualitative notation of apparent resistance of sediment column to coring/sampling, including notes on debris
9. Any deviation from the approved Work Package

During sediment sample processing, the following information should be recorded in the sample logsheet or field log:

1. Sample recovery (depth in feet of penetration and sample compaction)
2. Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency of soil, and color)
3. Odor (e.g., hydrogen sulfide, petroleum, etc.)
4. Vegetation
5. Debris

6. Biological activity (e.g., detritus, shells, tubes, bioturbation, or live or dead organisms)
7. Presence and depth (in feet) of the redox potential discontinuity layer
8. Presence of oil sheen
9. Any other distinguishing characteristics or features

5.1.1.1 Sample Identification

Sample identification will include depth interval information and will be performed as follows:

5.1.1.1.1 Sediment Cores and Grabs

The identification scheme for sediment cores and grabs will be as described below. For example, for sample PB###-XX###-X:

- PB###-XX###-X: Each location will be identified by PB, to depict the project location (Patrick Bayou), and the station identifier associated with the channel station in hundreds of feet (e.g., PB100). Samples collected in the East Fork will be designated with EF.
- PB###-XX###-X: Individual samples at each location will be identified by the same alphanumeric identifier used to identify the stations, followed by a one-digit numeric substation identifier, a two-digit matrix identifier (i.e., SC = sediment core and SS = surface sediment grab), and a three-digit number identifying the lower interval measurement (in cm) for that sample.
- PB###-XX###-X: An alphanumeric identifier indicating the sample type:
 - N – normal sample
 - D – field duplicate or homogenization split of the normal sample.

This information is included in detail for planned samples in Table 2 and 3.

5.1.2 Sample Handling and Transport

As described in the RI Work Plan QAPP, components of sample custody procedures include the use of field logbooks, sample labels, custody seals, and chain-of-custody (COC) forms. Each person involved with sample handling will be trained in COC

procedures before the start of the field program. The COC form will accompany the samples during shipment from the field to the laboratory.

5.1.3 Field Custody

The following procedures will be used to document, establish, and maintain custody of field samples:

1. Sample labels will be completed for each sample with waterproof ink, making sure that the labels are legible and affixed firmly on the sample container.
2. All sample-related information will be recorded in the project logbook.
3. The field sampler will retain custody of the samples until they are transferred or properly dispatched.
4. To simplify the COC record and minimize potential problems, as few people as possible should handle the samples. For this reason, one individual from the field sampling team will be designated as the responsible individual for all sample transfer activities. This field investigator will be responsible for the care and custody of the samples until they are properly transferred to another person or facility.
5. A COC form will accompany all samples. This record documents the transfer of custody of samples from the field sampler to the laboratory. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record.
6. Samples will be properly packaged for shipment and sent to the appropriate laboratory for analysis with a separate signed COC form, enclosed in a plastic bag, and taped inside the cover of each sample box or cooler. The original record will accompany the shipment, and a copy will be retained by the Field Supervisor. When samples are relinquished to shipping companies for transport, the tracking number will be recorded on the COC form.
7. The COC must be signed when relinquished by field personnel and signed by the laboratory receiving the samples.
8. Custody seals will be used on the shipping containers when samples are shipped to the laboratory to inhibit sample tampering during transportation.

5.1.4 Laboratory Sample Custody

Each laboratory receiving samples for this project must comply with the laboratory sample custody requirements outlined in its Quality Assurance Plan (QAP). The laboratory will designate a sample custodian who will be responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody. In addition, the laboratory will provide the following quality checks:

- The laboratory will check to see that there has been no tampering with the custody seals on the coolers.
- Upon receipt of the samples, the custodian will check the original COC and request-for-analysis documents and compare them with the labeled contents of each sample container for corrections and traceability. The sample custodian will sign the COC and record the date and time received in the 'Received by Laboratory' box.
- The sample custodian also will assign a unique laboratory sample number to each sample.
- Cooler temperature will be checked and recorded.
- Care will be exercised to annotate any labeling or descriptive errors. If discrepancies occur in the documentation, the laboratory will immediately contact the sample tracking coordinator and Project Chemist as part of the corrective action process. A qualitative assessment of each sample container will be performed to note anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming COC procedure.

Samples will be stored in a secured area and at a temperature of $4^{\circ} \pm 2^{\circ}\text{C}$, if necessary, until analyses are to begin. Unless otherwise specified by the Project Manager, samples will be retained for a period of 60 days after the final report is released by the laboratory, after which they will be disposed in accordance with the laboratory Standard Operating Procedures (SOP) for waste disposal.

5.1.5 Sample Packing and Shipping

During the field efforts, the Anchor Project Chemist will notify the appropriate laboratories about sample shipments. The Anchor Field Supervisor will fax copies of the COC to the Laboratory Project Manager for each day of sampling.

Hard plastic ice chests or coolers with similar durability will be used for shipping samples. The coolers must be able to withstand a 4-foot drop onto solid concrete in the position most likely to cause damage. Samples will be double-bagged in Ziploc bags and grouped by sample set. Styrofoam or bubble wrap will be used as packing material to protect the samples from leakage during shipment. A volume of ice approximately equal to the sample volume should be present in each cooler. Blue ice will not be used. After packing is complete, the cooler will be taped securely, with custody seals affixed across the top and bottom joints. In addition, these procedures will be followed when packing coolers of samples for shipping:

1. Include absorbent material in the cooler to absorb any ice melt.
2. Record the airbill on each COC.
3. List the appropriate contact person on the COC
4. Use custody seals on the cooler.

Samples will be shipped priority overnight FedEx or transported by courier (or equivalent) to the laboratory.

5.2 Hydrodynamic Related Data

5.2.1 Measurement Objectives

Practical constraints (i.e., budget, time, human performance, and instrument performance) will place limits on the amount, type, and quality of the data that can be collected. As a result, the project objectives must be balanced with the constraints of the collection effort. This section describes the measurement objectives that support the standards of data quality to meet the project objectives and those that are considered achievable given the practical constraints.

Measurement objectives for the following parameters are summarized in this section:

- Duration of data collection
- Frequency of data collection
- Temperature
- Specific conductivity
- Salinity

- Depth (surface water elevation)
- DO
- Velocity
- Discharge
- TSS

5.2.1.1 Duration of Data Collection

Data collection for all stations will be for the same, continuous period, beginning once the necessary DCPs have been installed and are operational. Once data collection has been initiated and station operation verified, the Anchor Field Supervisor will identify the nearest practical date to begin the data collection period. Suspending or extending the data collection period will not be done unless changes in the duration of collection are identified by the Anchor Field Supervisor and are approved by the Anchor Project Manager.

Specific data collection periods for hydrodynamic data are summarized in Table 1 and described in Section 2.1.2.

5.2.1.2 Frequency of Data Collection

Data collection will be continuous during the data collection period. Measurements will be taken at regular, pre-determined intervals. Table 1 and Section 2.1.2 summarize and describe the frequency of data collection.

5.2.1.3 Temperature

Temperature will be measured with an accuracy of $\pm 0.15^{\circ}\text{C}$ at a resolution of 0.01°C .

5.2.1.4 Specific Conductivity

Specific conductivity will be measured with an accuracy of ± 0.5 percent or $2\ \mu\text{S}/\text{cm}$ (whichever is greater) with a resolution of four significant figures.

5.2.1.5 *Salinity*

Based on the temperature, specific conductivity, and pressure measurements, salinity will be calculated with an accuracy of 1.0 percent, or ± 0.1 parts per thousand (ppt; whichever is greater) at a resolution of 0.01 ppt.

5.2.1.6 *Depth*

Depth (i.e., pressure) will be measured with an accuracy of ± 0.01 feet at a resolution of 0.001 feet. Each measurement will be an averaged reading taken over a continuous 60 second interval (minimum). Depth measurements will be used to calculate surface water elevation relative to the project datum (NAVD88) using measurements from the instrument and the results of the elevation survey.

5.2.1.7 *Dissolved Oxygen*

A YSI 600 OMS with a luminescent-based dissolved oxygen sensor and self-wiping mechanism will be used to measure DO. DO will be measured with an accuracy of ± 0.1 mg/L (0 to 20 mg/L) or ± 15 percent of reading (20 to 50 mg/L) with a resolution of 0.01 mg/L.

5.2.1.8 *Velocity*

Velocity will be measured with an accuracy of ± 1 percent of measured velocity or ± 0.5 cm/s, (whichever is greater) at a resolution of 0.1 cm/s. Each measurement will be an averaged measurement taken over a 60 second continuous sampling period (minimum). The integrating interval will be determined during the field deployment based on the diagnostic evaluation of signal strength and specific site conditions.

5.2.1.9 *Discharge*

Discharge will be calculated using the index-velocity method described in Morlock et al. (2002) and Ruhl and Simpson (2005). FlowPack software (Sontek/YSI, Inc.) or similar may be used to assist the index-velocity rating development.

5.2.1.10 TSS

TSS will be analyzed according to USEPA Method 160.2. Laboratory measurement objectives and analytical method requirements are described in Section 3. Samples will be handled and stored in accordance with the procedures described in Section 5.1.2 and Table 7.

5.2.2 Calibration Criteria

A calibration check will be performed on cleaned monitoring sensors during each field service event. A calibration check of the monitoring sensors is performed using calibration standards compared to the calibration criteria in Table 9. If the cleaned sensor readings for the monitor are within the calibration criteria, the monitoring sensors are considered checked and no further adjustments are required. If the reading is outside the acceptable range, the sensor must be recalibrated.

The checked and calibrated (if necessary) sensor reading is the beginning observation of the new water quality record interval. If the calibrated monitoring sensor fails to agree with the calibrated field instrument within the calibration criteria in Table 9, the faulty sensor must be repaired or replaced after verifying that the readings of the field meter are not in error. The alternative is to replace the monitoring sonde or sensor with a calibrated backup unit and repair the malfunctioning monitor in the laboratory or return it to the manufacturer for repair. The calibrated monitoring sensor will be returned to the water and allowed to equilibrate to the stream temperature. The manufacturer's recommendations regarding typical amount of time required for equilibration will be followed.

Velocity data from ADCPs is used directly as output from the system without any post processing. The velocity response will not change or drift with time, and the system typically does not require calibration. However, diagnostic parameters, signal strength and standard deviation will be checked for quality and accuracy of the data.

All information related to the sensor inspection will be recorded on a field form or in a field notebook. The sensor readings in the field notes become the basis for corrections

(shifts) during the record-processing stage. Complete and thorough documentation of the sensor inspection is important to maintaining data integrity.

5.2.3 Data Management and QA/QC

Document and record management is critical to project performance. The procedures in this section will ensure that data (including raw and processed data) reporting is prepared in a timely fashion. The data will be reviewed, approved, disseminated, and maintained, as required in this section and in accordance with the Site Data Management Plan (DMP) and QAPP, submitted as part of the RI Work Plan (Anchor 2006b). The following sections define data management and QA/QC procedures for field collected data not addressed in the DMP and QAPP.

5.2.3.1 Field Service Event Records and Data Downloads

During each field servicing event, continuously logged data from the instruments will be downloaded and transferred to a handheld datalogger, laptop computer, or handheld PC, as appropriate. Download, file naming conventions, and file transfer procedures will be included in the field service event standard operating procedures. Written field notes will be taken noting the date, time, location, instrument, and file name for each data collection instrument download event. Any problems or issues with data downloading in the field will be noted as well.

Upon completion of each field servicing and data download event, the field team leader will transfer raw data files to the Anchor server network at the appropriate directory determined by the Anchor Project Manager and in accordance with the DMP.

Subsequent to each field servicing event, the Anchor Field Supervisor will make one copy of all field notes and continuous recorder calibration sheets and other pertinent records. A brief field servicing event report will be generated that describes any logistical problems encountered in the field and any potential impacts to the data. This report will be provided to the Anchor Project Manager and a copy placed in the project file.

5.2.3.2 Data Entry and Verification

Following each field servicing and data download event, the field team leader will load the raw data files into the appropriate spreadsheet or database for processing and quality assurance/quality control (QA/QC). The required information from the field servicing event notes and continuous recorder calibration sheets will be loaded into the spreadsheet/database as well. The Anchor Field Supervisor will perform and verify electronic shifts of data and will construct graphs of shifted specific conductance, depth, salinity, DO, velocity, and discharge. Shifted, verified data will be imported to the project database as appropriate. Specific QA/QC considerations are described below.

Subsequent to the validation process, any edits, deletions, or other changes to the data (other than shifts) will be flagged and documented in the master database.

5.2.3.3 Data Validation and Review

Data validation will be conducted in two phases, each phase performed by a different person. Phase 1 will be performed by the individual responsible for field collection of data (field team leader); Phase 2 will be executed by a designated data management QA/QC officer. General responsibilities and procedures are described below.

5.2.3.3.1 Phase 1 – Initial Data Validation

Phase 1 will be performed by the field team leader or designee during the initial data entry and verification. Once continuous data and appropriate information from the calibration sheets and field logs are loaded into the appropriate spreadsheet or database, the following QA/QC procedures for the current record will be performed:

1. Application and verification of shifts and corrections—Corrections to the data, in the form of electronic shifts, will be applied to parameters if the absolute value of the sum of the measurement error due to fouling and calibration drift exceed the criteria in Table 10. Electronic shifts will be linear interpolations (single-point corrections) of the recorded data since the previous datum record. Shifts for the current datum record will be

compared to the quality control limits in Table 10. These quality control limits, or maximum allowable limits are generally 10 times the calibration criteria (Table 9). If the recorded values differ from the corrected values by more than the maximum allowable limits, the data records will be flagged and the data for that parameter will not be considered usable.

The calculation of ADCP velocity data will be checked to ensure that the signal strength remained 10 counts (43 dB) above the reported noise level. Passing debris could cause drops in signal strength. Data will be flagged if the signal strength does not meet this requirement.

2. Graphical evaluation of the current datum record—Graphs of temperature, shifted conductance, shifted depth, shifted salinity, and velocity will be evaluated and any missing readings (data gaps), out-of-range, or suspect values will be identified and flagged.

Once the current datum record has been validated, it will be imported into the project database and appended to the station record. The following QA/QC procedures will be performed for the station record:

- The data will be checked for normal transition between the last datum record (previous month's data) and the present datum record.
- A Phase 1 data validation report package will be prepared that will include: (a) QA/QC data checklist; (b) continuous recorder calibration sheets; (c) electronic data files (current datum record and updated project database); and (d) field trip report.

5.2.3.3.2 Phase 2 – Data Validation Review

The Project QA Manager will review the initial data validation report package(s) provided by the Anchor Field Supervisor. The following QA/QC procedures will be performed by the Project QA Manager:

- Validation of shifts and corrections
- Validation of flagged data
- Completion of a data validation checklist

The Project QA Manager will be responsible for maintaining the reviewed data validation reports, consisting of the signed checklist and initial data validation report.

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TABLES

Table 1
Summary of Hydrodynamic and Sediment Transport Modeling Data Collection Task Study Design

Station	Field Parameters	Frequency	Collection Period
PB75	WSE	15 minutes / 1 hour**	1 month / 11 months**
	Velocity	15 minutes / 1 hour**	1 month / 11 months**
	Discharge*	15 minutes / 1 hour**	1 month / 11 months**
	TSS	3 hours	1 month
	Conductivity	15 minutes / 1 hour**	1 month / 11 months**
	Dissolved Oxygen	15 minutes / 1 hour**	1 month / 11 months**
	Temperature	15 minutes / 1 hour**	1 month / 11 months**
	Salinity*	15 minutes / 1 hour**	1 month / 11 months**
EF05	WSE	15 minutes / 1 hour**	1 month / 8 months**
	Velocity	15 minutes / 1 hour**	1 month / 11 months**
	Discharge*	15 minutes / 1 hour**	1 month / 11 months**
	Conductivity	15 minutes / 1 hour**	1 month / 11 months**
	TSS	3 hours	1 month
	Dissolved Oxygen	15 minutes / 1 hour**	1 month / 11 months**
	Temperature	15 minutes / 1 hour**	1 month / 11 months**
	Salinity*	15 minutes / 1 hour**	1 month / 11 months**
PB45	WSE	15 minutes / 1 hour**	1 month / 11 months**
	Velocity	15 minutes / 1 hour**	1 month / 11 months**
	Conductivity	15 minutes / 1 hour**	1 month / 11 months**
	Dissolved Oxygen	15 minutes / 1 hour**	1 month / 11 months**
	Temperature	15 minutes / 1 hour**	1 month / 11 months**
	Salinity*	15 minutes / 1 hour**	1 month / 11 months**
PB020	WSE	15 minutes / 1 hour**	1 month / 8 months**
	Velocity	15 minutes / 1 hour**	1 month / 11 months**
	Conductivity	15 minutes / 1 hour**	1 month / 11 months**
	Dissolved Oxygen	15 minutes / 1 hour**	1 month / 11 months**
	Temperature	15 minutes / 1 hour**	1 month / 11 months**
	Salinity*	15 minutes / 1 hour**	1 month / 11 months**
PB012	TSS	3 hours	1 month

* Calculated value; not measured directly by instrumentation

** Measurements will be recorded every 15 minutes for 1 month followed by measurements every hour for an additional 11 months.

Table 2
Summary of Source Evaluation Sediment Sampling Study Design

Station ID ^c	Sample ID [†]	Depth Interval (cm) ^{c,*}	Station Coordinates ^a		Metals ^b	Mercury	PCB Aroclors ^b	PAH ^b	Pesticides ^b	TOC
			Northing	Easting						
PB101	PB101-1SS002-N	0-2	13828192.83	3201310.38	X	X	X	X	X	X
PB119	PB119-1SS002-N	0-2	13826344.50	3201533.38	X	X	X	X	X	X
PB123	PB123-1SS002-N	0-2	13826005.27	3201452.98	X	X	X	X	X	X
EF008	EF008-1SS002-N	0-2	13830923.34	3202129.31	X	X	X	X	X	X
Quality Assurance / Quality Control										
PB### ^d	PB###-#XX###-D	0-2	TBD	TBD	1 ^e	1	1	1	1	1

Notes:

- a Station Coordinates are State Plane coordinates based on North American Datum (NAD) 83 for Texas, South Central.
- b See Table 4 for complete list of analytes included in analyses.
- c Specific station and interval may be changed in the field to best represent site conditions.
- d Location to be determined in field based on site conditions. Samples to be named in accordance with Section 5.1.1
- e Represent the number of samples to be taken for each analyte class
- † Additional sample locations will be identified based on field reconnaissance survey. Up to an additional 16 locations may be sampled.
- TBD To be determined

Table 3
Summary of Vertical Characterization Sediment Sampling Study Design

Station ID ^c	Sample ID	Depth Interval (cm) ^{c,*}	Station Coordinates ^a		Metals ^b	Mercury	PCB Congeners	PCB Aroclors ^b	Dioxins/Furans ^b	PAH ^b	SVOC ^b	VOC ^b	Pesticides ^b	TOC	Grain size	Cesium-137 ^d
			Northing	Easting												
PB003	PB003-1SS002-N	0 - 2	13836425.37	3202339.46	X	X		X	X	X	X		X	X	X	
PB003	PB003-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
PB003	PB003-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
PB003	PB003-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB003	PB003-2SC004-N	0 - 4														X
PB003	PB003-2SC032-N	29 - 32														X
PB003	PB003-2SC064-N	61 - 64														X
PB003	PB003-2SC096-N	93 - 96														X
PB003	PB003-2SC128-N	125 - 128														X
PB003	PB003-2SCXXX-N	+ 32 cm														X
PB009	PB009-1SS002-N	0 - 2	13836190.69	3201850.92	X	X		X		X	X		X	X	X	
PB009	PB009-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X	
PB009	PB009-1SC042-N	11 - 41			X	X		X		X	X	X	X	X	X	
PB009	PB009-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X	
PB016	PB016-1SS002-N	0 - 2	13836120.76	3201194.62	X	X		X	X	X	X		X	X	X	
PB016	PB016-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
PB016	PB016-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
PB016	PB016-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB018	PB018-1SS002-N	0 - 2	13835837.70	3201070.29	X	X		X		X	X		X	X	X	
PB018	PB018-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X	
PB018	PB018-1SC042-N	11 - 41			X	X		X		X	X	X	X	X	X	
PB018	PB018-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X	
PB022	PB022-1SS002-N	0 - 2	13835498.23	3201097.95	X	X		X	X	X	X		X	X	X	
PB022	PB022-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
PB022	PB022-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
PB022	PB022-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB022	PB022-2SC004-N	0 - 4														X
PB022	PB022-2SC032-N	29 - 32														X
PB022	PB022-2SC064-N	61 - 64														X
PB022	PB022-2SC096-N	93 - 96														X
PB022	PB022-2SC128-N	125 - 128														X
PB022	PB022-2SCXXX-N	+ 32 cm														X
PB030	PB030-1SS002-N	0 - 2	13834707.34	3201335.33	X	X		X		X	X		X	X	X	
PB030	PB030-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X	
PB030	PB030-1SC042-N	11 - 41			X	X		X		X	X	X	X	X	X	
PB030	PB030-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X	
PB036	PB036-1SS002-N	0 - 2	13834114.31	3201378.46	X	X		X	X	X	X		X	X	X	
PB036	PB036-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
PB036	PB036-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
PB036	PB036-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB036	PB036-2SC004-N	0 - 4														X
PB036	PB036-2SC032-N	29 - 32														X
PB036	PB036-2SC064-N	61 - 64														X
PB036	PB036-2SC096-N	93 - 96														X

Station ID ^c	Sample ID	Depth Interval (cm) ^{c,*}	Station Coordinates ^a		Metals ^b	Mercury	PCB Congeners	PCB Aroclors ^b	Dioxins/Furans ^b	PAH ^b	SVOC ^b	VOC ^b	Pesticides ^b	TOC	Grain size	Cesium-137 ^d
			Northing	Easting												
PB036	PB036-2SC128-N	125 - 128	13833551.36	3201354.53												X
PB036	PB036-2SCXXX-N	+ 32 cm														X
PB042	PB042-1SS002-N	0 - 2			X	X		X	X	X			X	X	X	
PB042	PB042-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X	
PB042	PB042-1SC042-N	11 - 41			X	X		X		X	X	X	X	X	X	
PB042	PB042-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X	
PB048	PB048-1SS002-N	0 - 2	13832959.40	3201502.80	X	X		X	X	X			X	X	X	
PB048	PB048-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
PB048	PB048-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
PB048	PB048-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB048	PB048-2SC004-N	0 - 4														X
PB048	PB048-2SC032-N	29 - 32														X
PB048	PB048-2SC064-N	61 - 64														X
PB048	PB048-2SC096-N	93 - 96														X
PB048	PB048-2SC128-N	125 - 128														X
PB048	PB048-1SCXXX-N	+ 32 cm														X
PB057	PB057-1SS002-N	0 - 2	13832096.55	3201519.36	X	X		X		X	X		X	X	X	
PB057	PB057-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X	
PB057	PB057-1SC042-N	11 - 41			X	X		X		X	X	X	X	X	X	
PB057	PB057-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X	
PB057	PB057-2SC004-N	0 - 4														X
PB057	PB057-2SC032-N	29 - 32														X
PB057	PB057-2SC064-N	61 - 64														X
PB057	PB057-2SC096-N	93 - 96														X
PB057	PB057-2SC128-N	125 - 128														X
PB057	PB057-2SCXXX-N	+ 32 cm														X
EF001	EF001-1SS002-N	0 - 2	13831226.21	3201612.72	X	X		X	X	X	X		X	X	X	
EF001	EF001-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
EF001	EF001-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
EF001	EF001-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB063	PB063-1SS002-N	0 - 2	13831338.02	3201542.97	X	X		X	X	X	X		X	X	X	
PB063	PB063-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
PB063	PB063-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
PB063	PB063-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB067	PB067-1SS002-N	0 - 2	13831216.18	3201354.56	X	X		X		X	X		X	X	X	
PB067	PB067-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X	
PB067	PB067-1SC042-N	11 - 41			X	X		X		X	X	X	X	X	X	
PB067	PB067-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X	
PB073	PB073-1SS002-N	0 - 2	13830742.28	3201037.34	X	X		X	X	X	X		X	X	X	
PB073	PB073-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X	X	X	
PB073	PB073-1SC042-N	11 - 41			X	X		X	X	X	X	X	X	X	X	
PB073	PB073-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X	X	
PB077	PB077-1SS002-N	0 - 2	13830368.06	3200780.25	X	X		X		X	X		X	X	X	
PB077	PB077-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X	
PB077	PB077-1SC042-N	11 - 41			X	X		X		X	X	X	X	X	X	
PB077	PB077-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X	

Station ID ^c	Sample ID	Depth Interval (cm) ^{c,*}	Station Coordinates ^a		Metals ^b	Mercury	PCB Congeners	PCB Aroclors ^b	Dioxins/Furans ^b	PAH ^b	SVOC ^b	VOC ^b	Pesticides ^b	TOC	Grain size	Cesium-137 ^d		
			Northing	Easting														
PB084	PB084-1SS002-N	0 - 2	13829634.22	3200707.36	X	X		X	X	X	X		X	X	X			
PB084	PB084-1SC011-N	0 - 11			X	X	X	X	X	X	X	X	X					
PB084	PB084-1SC042-N	11 -41			X	X		X	X	X	X	X	X	X				
PB084	PB084-1SCXXX-N	+ 30 cm			X	X		X	X	X	X	X	X	X				
PB084	PB084-2SC004-N	0 - 4															X	
PB084	PB084-2SC032-N	29 - 32																X
PB084	PB084-2SC064-N	61 - 64																X
PB084	PB084-2SC096-N	93 - 96																X
PB084	PB084-2SC128-N	125 - 128																X
PB084	PB084-2SCXXX-N	+ 32 cm																X
PB094	PB094-1SS002-N	0 - 2	13828774.24	3201009.01	X	X		X		X	X		X	X	X			
PB094	PB094-1SC011-N	0 - 11			X	X	X	X		X	X	X	X	X	X			
PB094	PB094-1SC042-N	11 -41			X	X		X		X	X	X	X	X	X			
PB094	PB094-1SCXXX-N	+ 30 cm			X	X		X		X	X	X	X	X	X			
Field Quality Assurance / Quality Control Samples																		
PB### ^e	PB###-#XX###-D	TBD	TBD	TBD	4 ^f	4	1	4	2	4	4	3	4	4	0	2		
EB/ER ^g	EB#/ER#	NA	NA	NA								2						
Trip Blank	TB#	NA	NA	NA								4 ^h						

Notes:

- a Station Coordinates are State Plane coordinates based on North American Datum (NAD) 83 for Texas, South Central
- b See Table 3 for complete list of analytes/congeners included in analyses
- c Specific station and interval may be changed in the field to best represent site conditions
- d Radioisotope analysis for Cesium-137 will be performed on this interval; number of intervals per site will be dependent on sediment depth
- e Location to be determined in field based on site conditions. Samples to be named in accordance with Section 5.1.1
- f Represent the number of samples to be taken for each analyte class
- g Equipment blank / Equipment rinsate
- h One per shipment to the laboratory

TBD To be determined

* Depth intervals will vary for each site; sediment will be collected from 0-11 cm, and then at 30-cm intervals to the depth of refusal (0 - 11 cm, 12 - 42 cm, 43 - 73 cm, 74 - 104 cm, 105 - 135 cm, 136 - 166 cm, **etc.**)

Table 4
Parameters for Analysis and Target Practical Quantitation Limits for Sediment

	Units	Sediment Target PQL	Analytical Method	Sediment Quality Guidelines ^a	
				TEL	ERL
SEDIMENT					
Conventional Parameters					
Gravel	%	0.1	PSEP	--	--
Sand	%	0.1	PSEP	--	--
Silt	%	0.1	PSEP	--	--
Clay	%	0.1	PSEP	--	--
Fines	%	0.1	PSEP	--	--
Total solids	%	0.1	160.3M	--	--
Total organic carbon	%	0.1	9060A	--	--
Metals					
Mercury	mg/kg	0.05	7470A / 7471A	0.13	0.15
Total metals (As)	mg/Kg	0.5	6020	7.24	8.2
Total metals (Cd)	mg/kg	0.05	6020	0.676	1.2
Total metals (Cr)	mg/kg	2	6020	52.3	81.0
Total metals (Cu)	mg/kg	0.2	6020	18.7	34
Total metals (Pb)	mg/kg	2.0	6020	30.2	46.7
Total metals (Ni)	mg/kg	0.2	6020	15.9	20.9
Total metals (Ag)	mg/kg	0.02	6020	0.73	1.0
Total metals (Ba)	mg/kg	0.3	6010B / 6020	--	--
Total metals (Se)	mg/kg	1	7000 series GFAA	--	--
Total metals (Zn)	mg/kg	0.6	6010B / 6020	124	150
Radiochemistry					
Cesium ¹³⁷	pCi/g	0.1	901.1m	--	--
Semivolatile Organics					
LPAH					
Naphthalene	µg/kg	6.7	8270C/ SIM	34.6	160
Acenaphthalene	µg/kg	6.7	8270C/ SIM	5.9	44
Acenaphthene	µg/kg	6.7	8270C/ SIM	6.7	16
Fluorene	µg/kg	6.7	8270C/ SIM	21.2	19
Phenanthrene	µg/kg	6.7	8270C/ SIM	86.7	240
Anthracene	µg/kg	6.7	8270C/ SIM	46.9	85.3
2-Methylnaphthalene	µg/kg	6.7	8270C/ SIM	20.2	70
1-Methylnaphthalene	µg/kg	6.7	8270C/ SIM	--	--
HPAH					
Fluoranthene	µg/kg	6.7	8270C/ SIM	112.8	600
Pyrene	µg/kg	6.7	8270C/ SIM	152.7	665
Benz(a)anthracene	µg/kg	6.7	8270C/ SIM	74.8	261
Chrysene	µg/kg	6.7	8270C/ SIM	107.8	384
Benzo(k)fluoranthene	µg/kg	6.7	8270C/ SIM	--	--
Benzo(a)pyrene	µg/kg	6.7	8270C/ SIM	88.8	430

	Units	Sediment Target PQL	Analytical Method	Sediment Quality Guidelines ^a	
				TEL	ERL
Benzo(e)pyrene	µg/kg	6.7	8270C/ SIM	--	--
Indeno(1,2,3-cd) pyrene	µg/kg	6.7	8270C/ SIM	--	--
Benzo(b)fluoranthene	µg/kg	6.7	8270C/ SIM	--	--
Dibenz(a,h)anthracene	µg/kg	6.7	8270C/ SIM	6.2	63.4
Benzo(g,h,i)perylene	µg/kg	6.7	8270C/ SIM	--	--
Perylene	ug/kg	6.7	8270C/ SIM	--	--
Alkyl-substituted PAH homologs					
C1-Naphthalenes	µg/kg	6.7	8270C/ SIM	--	--
C1-Chrysenes	µg/kg	6.7	8270C/ SIM	--	--
C1-Fluoranthenes/Pyrenes	µg/kg	6.7	8270C/ SIM	--	--
C1-Fluorenes	µg/kg	6.7	8270C/ SIM	--	--
C1-Phenanthrenes/Anthracenes	µg/kg	6.7	8270C/ SIM	--	--
C2-Chrysenes	µg/kg	6.7	8270C/ SIM	--	--
C2-Fluorenes	µg/kg	6.7	8270C/ SIM	--	--
C2-Naphthalenes	µg/kg	6.7	8270C/ SIM	--	--
C2-Phenanthrenes/Anthracenes	µg/kg	6.7	8270C/ SIM	--	--
C3-Chrysenes	µg/kg	6.7	8270C/ SIM	--	--
C3-Fluorenes	µg/kg	6.7	8270C/ SIM	--	--
C3-Naphthalenes	µg/kg	6.7	8270C/ SIM	--	--
C3-Phenanthrenes/Anthracenes	µg/kg	6.7	8270C/ SIM	--	--
C4-Chrysenes	µg/kg	6.7	8270C/ SIM	--	--
C4-Naphthalenes	µg/kg	6.7	8270C/ SIM	--	--
C4-Phenanthrenes/Anthracenes	µg/kg	6.7	8270C/ SIM	--	--
Misc. Semivolatile organics					
4-Bromophenyl-phenylether	ug/Kg	10	LL-8270	--	--
4-Chlorophenyl-phenylether	ug/Kg	10	LL-8270	--	--
Hexachlorobenzene	µg/kg	1	8081	--	--
Hexachlorobutadiene	µg/kg	1	8081	--	--
Hexachloroethane	µg/kg	10	LL-8270	--	--
2,6-Dinitrotoluene	µg/kg	10	LL-8270	--	--
Benzidine	NA	NA	NA	--	--
Bis(2-Chloroisopropyl)ether	µg/kg	10	LL-8270	--	--
Bis(2-Ethylhexyl)phthalate	µg/kg	200	LL-8270	--	182.6
Dimethylphthalate	µg/kg	10	LL-8270	--	--
Volatile Organics					
1,1,1,2-Tetrachloroethane	µg/kg	5.0	8260B	--	--
1,1,1-Trichloroethane (TCA)	µg/kg	5.0	8260B	--	--
1,1,2,2-Tetrachloroethane	µg/kg	5.0	8260B	--	--
1,1,2-Trichloroethane	µg/kg	5.0	8260B	--	--
1,1-Dichloroethane	µg/kg	5.0	8260B	--	--
1,1-Dichloroethene	µg/kg	5.0	8260B	--	--
1,1-Dichloropropene	µg/kg	5.0	8260B	--	--
1,2,3-Trichlorobenzene	µg/kg	20	8260B	--	--
1,2,3-Trichloropropane	µg/kg	5.0	8260B	--	--

	Units	Sediment Target PQL	Analytical Method	Sediment Quality Guidelines ^a	
				TEL	ERL
1,2,4-Trichlorobenzene	µg/kg	20	8260B	--	--
1,2,4-Trimethylbenzene	µg/kg	20	8260B	--	--
1,2-Dibromo-3-chloropropane	µg/kg	20	8260B	--	--
1,2-Dibromoethane (EDB)	µg/kg	20	8260B	--	--
1,2-Dichlorobenzene	µg/kg	5.0	8260B	--	--
1,2-Dichloroethane (EDC)	µg/kg	5.0	8260B	--	--
1,2-Dichloropropane	µg/kg	5.0	8260B	--	--
1,3,5-Trimethylbenzene	µg/kg	20	8260B	--	--
1,3-Dichlorobenzene	µg/kg	5.0	8260B	--	--
1,3-Dichloropropane	µg/kg	5.0	8260B	--	--
1,4-Dichlorobenzene	µg/kg	5.0	8260B	--	--
1,4-Dichlorobenzene-d4	µg/kg	5	8260B	--	--
2,2-Dichloropropane	µg/kg	5.0	8260B	--	--
2-Butanone (MEK)	µg/kg	20	8260B	--	--
2-Chlorotoluene	µg/kg	20	8260B	--	--
2-Hexanone	µg/kg	20	8260B	--	--
4-Bromofluorobenzene	µg/kg	5.0	8260B	--	--
4-Chlorotoluene	µg/kg	20	8260B	--	--
4-Isopropyltoluene	µg/kg	20	8260B	--	--
4-Methyl-2-pentanone (MIBK)	µg/kg	20	8260B	--	--
Acetone	µg/kg	20	8260B	--	--
Benzene	µg/kg	5.0	8260B	--	--
Bromobenzene	µg/kg	5.0	8260B	--	--
Bromochloromethane	µg/kg	5.0	8260B	--	--
Bromodichloromethane	µg/kg	5.0	8260B	--	--
Bromoform	µg/kg	5.0	8260B	--	--
Bromomethane	µg/kg	5.0	8260B	--	--
Carbon Disulfide	µg/kg	5.0	8260B	--	--
Carbon Tetrachloride	µg/kg	5.0	8260B	--	--
Chlorobenzene	µg/kg	5.0	8260B	--	--
Chlorobenzene-d5	µg/kg	5	8260B	--	--
Chloroethane	µg/kg	5.0	8260B	--	--
Chloroform	µg/kg	5.0	8260B	--	--
Chloromethane	µg/kg	5.0	8260B	--	--
cis-1,2-Dichloroethene	µg/kg	5.0	8260B	--	--
cis-1,3-Dichloropropene	µg/kg	5.0	8260B	--	--
Dibromochloromethane	µg/kg	5.0	8260B	--	--
Dibromofluoromethane	µg/kg	5.0	8260B	--	--
Dibromomethane	µg/kg	5.0	8260B	--	--
Dichlorodifluoromethane	µg/kg	5.0	8260B	--	--
Ethylbenzene	µg/kg	5.0	8260B	--	--
Fluorobenzene	µg/kg	5	8260B	--	--
Hexachlorobutadiene	µg/kg	20	8260B	--	--
Isopropylbenzene	µg/kg	20	8260B	--	--

	Units	Sediment Target PQL	Analytical Method	Sediment Quality Guidelines ^a	
				TEL	ERL
m,p-Xylenes	µg/kg	5.0	8260B	--	--
Methylene Chloride	µg/kg	10	8260B	--	--
Naphthalene	µg/kg	20	8260B	--	--
n-Butylbenzene	µg/kg	20	8260B	--	--
n-Propylbenzene	µg/kg	20	8260B	--	--
o-Xylene	µg/kg	5.0	8260B	--	--
sec-Butylbenzene	µg/kg	20	8260B	--	--
Styrene	µg/kg	5.0	8260B	--	--
tert-Butylbenzene	µg/kg	20	8260B	--	--
Tetrachloroethene (PCE)	µg/kg	5.0	8260B	--	--
Toluene	µg/kg	5.0	8260B	--	--
Toluene-d8	µg/kg	5.0	8260B	--	--
trans-1,2-Dichloroethene	µg/kg	5.0	8260B	--	--
trans-1,3-Dichloropropene	µg/kg	5.0	8260B	--	--
Trichloroethene (TCE)	µg/kg	5.0	8260B	--	--
Trichlorofluoromethane	µg/kg	5.0	8260B	--	--
Vinyl Chloride	µg/kg	5.0	8260B	--	--
PCBs					
PCB Congeners (1-209)	pg/g	12.5	1668	--	--
PCB Aroclors					
Aroclor 1016	µg/kg	1.6	8082	--	--
Aroclor 1221	µg/kg	1.6	8082	--	--
Aroclor 1232	µg/kg	1.6	8082	--	--
Aroclor 1242	µg/kg	1.6	8082	--	--
Aroclor 1248	µg/kg	1.6	8082	--	--
Aroclor 1254	µg/kg	1.6	8082	--	--
Aroclor 1260	µg/kg	1.6	8082	--	--
Aroclor 1262	µg/kg	1.6	8082	--	--
Aroclor 1268	µg/kg	1.6	8082	--	--
Organochlorine Pesticides					
2,2'DDD	µg/kg	1.0	8081A	--	--
2,2'DDE	µg/kg	1.0	8081A	--	--
2,2'DDT	µg/kg	1.0	8081A	--	--
4,4'DDD	µg/kg	1.0	8081A	1.2	2
4,4'DDE	µg/kg	1.0	8081A	2.1	2.2
4,4'DDT	µg/kg	1.0	8081A	1.2	1.0
Aldrin	µg/kg	1.0	8081A	--	--
alpha-Chlordane	µg/kg	1.0	8081A	2.26	0.5
Dieldrin	µg/kg	1.0	8081A	0.72	0.02
Delta-BHC	µg/kg	1.0	8081A	--	--
Endosulfan I	µg/kg	1.0	8081A	--	--
Endosulfan II	µg/kg	1.0	8081A	--	--
Endosulfan Sulfate	µg/kg	1.0	8081A	--	--
Endrin*	µg/kg	1.0	8081A	--	--

	Units	Sediment Target PQL	Analytical Method	Sediment Quality Guidelines ^a	
				TEL	ERL
Heptachlor	µg/kg	1.0	8081A	--	--
Heptachlor epoxide	µg/kg	1.0	8081A	--	--
Gamma-BHC (lindane)	µg/kg	1.0	8081A	0.32	--
Gamma-Chlordane	µg/kg	1.0	8081A	2.26	0.5
Methoxychlor	µg/kg	1.0	8081A	--	--
Dioxins and Furans					
2,3,7,8-Tetrachlorodibenzo-p-dioxin	pg/g	0.08	8290	--	--
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	pg/g	0.06	8290	--	--
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	pg/g	0.20	8290	--	--
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/g	0.20	8290	--	--
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/g	0.20	8290	--	--
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/g	0.15	8290	--	--
Octachlorodibenzo-p-dioxin	pg/g	0.08	8290	--	--
2,3,7,8-Tetrachlorodibenzofuran	pg/g	0.08	8290	--	--
1,2,3,7,8-Pentachlorodibenzofuran	pg/g	0.14	8290	--	--
2,3,4,7,8-Pentachlorodibenzofuran	pg/g	0.14	8290	--	--
1,2,3,4,7,8-Hexachlorodibenzofuran	pg/g	0.10	8290	--	--
1,2,3,6,7,8-Hexachlorodibenzofuran	pg/g	0.10	8290	--	--
1,2,3,7,8,9-Hexachlorodibenzofuran	pg/g	0.10	8290	--	--
2,3,4,6,7,8-Hexachlorodibenzofuran	pg/g	0.15	8290	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/g	0.20	8290	--	--
1,2,3,4,7,8,9-Hepachlorodibenzofuran	pg/g	0.20	8290	--	--
Octachlorodibenzofuran	pg/g	0.25	8290	--	--
SURFACE WATER					
Conventional Parameters					
Total suspended solids	mg/L	10	160.2	--	--

Notes:

All chemicals results reported on dry weight basis

a NOAA SQuIRTs table (Buchman 1999)

b The full list of Volatile Organics will be reported

TEL - Threshold effects limit

ERL - Effects range low

'--' Not available

Table 5
Laboratory Quality Control Sample Summary

Analysis Type	Initial Calibration	Ongoing Calibration	Standard Reference Material or LCS/LCSD	Replicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Grain size	Each batch ^a	NA	NA	1 per 20 samples	NA	NA	NA	NA
TOC	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
TSS	Daily ^d	NA	NA	1 per 20 samples	NA	NA	NA	NA
Metals, Total	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
Mercury	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
Radiochemistry	Yearly	Twice weekly	1 per 20 samples ^{e,f}	1 per 20 samples	1 per 20 samples ^{e,f}	1 per 20 samples ^{e,f}	1 per 20 samples ^{e,f}	NA
Polychlorinated biphenyls	As needed ^c	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample
Organochlorine pesticides	As needed ^c	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample
SVOC	As needed ^c	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample
VOC	As needed ^c	Every 12 hours	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample
Dioxins and furans	As needed ^c	1 per 10 samples	1 per 20 samples	NA	1 per 20 samples	1 per 20 samples	Each batch	Every sample

Notes:

- a Calibration and certification of drying ovens and weighing scales are conducted bi-annually.
- b Initial calibration verification and calibration blank must be analyzed at the beginning of each batch.
- c Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.
- d Scale should be calibrated with class 5 weights daily, weights must bracket the weight of sample and weighing vessel.
- e Standard reference material is not applicable for this analysis. There is also no surrogate spike to be used for the analysis
- f If sufficient material is available
- NA Not applicable
- LCS Laboratory control sample / laboratory control sample duplicate

Table 6
Laboratory Measurement Objectives for Sediment Samples

Parameter	Precision	Accuracy	Completeness
Grain size	+/- 20% RPD	NA	95%
Total suspended solids	+/- 20% RPD	NA	95%
Metals, Total	+/- 20% RPD	65-130% R	95%
Total organic carbon	+/- 20% RPD	65-130% R	95%
Radiochemistry	+/- 25% RPD	65-135% R	95%
Organochlorine pesticides	+/- 50% RPD	50-140% R	95%
Polychlorinated biphenyls	+/- 50% RPD	50-140% R	95%
SVOC	+/- 50% RPD	50-140% R	95%
VOC	+/- 50% RPD	50-140% R	95%
Dioxins/Furans	+/- 50% RPD	50-140% R	95%

Notes:

RPD Relative percent difference
R Recovery

Table 7
Sample Containers, Preservatives, and Holding Times

Parameter	Container Size and Type	Holding Time	Preservative
Dioxins/Furans	8-oz Glass	14 days until extraction	Cool/4° C
PCBs congeners	8-oz Glass	14 days until extraction	Cool/4° C
Metals, Total	4-oz Glass	14 days until extraction	Cool/4° C
Mercury, Total			
PCB Aroclors	16-oz Glass	14 days until extraction	Cool/4° C
Organochlorine pesticides			
SVOC			
VOC	2-oz Glass	14 days until extraction	Cool/4° C
Radiochemistry	4-oz Glass	NA	NA
Archive	16-oz Glass	30 days	Cool/4° C
Total Organic Carbon	4-oz Glass	28 days	Cool/4o C
Grain Size	16-oz Plastic	6 months	NA
Total suspended solids	Glass	7 days	Cool/4° C
Trip blanks	2 x 40 ml VOA vials	14 days until extraction	HCl ph<2 Cool/4° C
Equipment rinsate / field blank	2 x 40 ml VOA vials	14 days until extraction	HCl ph<2 Cool/4° C

Notes:

PCBs polychlorinated biphenyls
VOC volatile organic compounds
SVOC semivolatile organic compounds
NA not applicable

Table 8
Summary of Station Location Coordinates

Station ID	Station Coordinates ^a	
	Northing	Easting
Vertical Profiling Task		
PB003	13836425.37	3202339.46
PB009	13836190.69	3201850.92
PB016	13836120.76	3201194.62
PB018	13835837.70	3201070.29
PB022	13835498.23	3201097.95
PB030	13834707.34	3201335.33
PB036	13834114.31	3201378.46
PB042	13833551.36	3201354.53
PB048	13832959.40	3201502.80
PB057	13832096.55	3201519.36
EF001	13831226.21	3201612.72
PB063	13831338.02	3201542.97
PB067	13831216.18	3201354.56
PB077	13830368.06	3200780.25
Source characterization Task		
EF008	13830923.34	3202129.31
PB101	13828192.83	3201310.38
PB119	13826344.50	3201533.38
PB123	13826005.27	3201452.98
Hydrodynamic Data Task*		
PB012	13836226.37	3201552.45
PB020	13835041.74	3201321.91
PB045	13833154.73	3201698.94
EF005	13830529.34	3200876.80
PB075	13831158.08	3201756.55

Notes:

- a Station Coordinates are State Plane coordinates based on North American Datum (NAD) 83 for Texas, South
- * Locations are approximate and may be adjusted in the field

Table 9
Calibration Criteria for Continuous Water-Quality Instruments

Measured Physical Property	Calibration Criteria for Measurements
Temperature	N/A; field calibration not available
Velocity	N/A; field calibration not required (see text)
Specific Conductance	Percent difference exceeds 5.0 between cleaned monitoring instrument and calibration standard solution
Depth	Cleaned depth out of water is not 0.00 ft
Dissolved oxygen	+/- 0.3 mg/L between instrument reading at 100% saturation in air and expected solubility of oxygen (determined from http://water.usgs.gov/cgi-bin/dotables)

N/A = Not applicable

Table 10
Parameter Shift Criteria and Maximum Allowable Limits for Continuous Hydrodynamic Monitoring Sensors

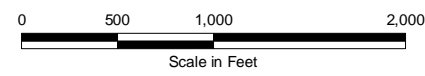
Measured Physical Property	Parameter Shift Criteria	Maximum Allowable Limits for Sensor Values
Temperature	N/A	2.0° C between cleaned monitoring instrument and the calibration instrument
Specific conductivity	± 5% difference between dirty continuous recorder measurement and calibrated continuous recorder*	±50% between cleaned continuous recorder instrument and the calibrated instrument
Velocity	N/A	10 Counts (43dB) above reported noise levels.
Depth	±5% difference between dirty depth reading and cleaned depth reading OR dirty depth out of water reading and cleaned sensor out of water reading	0.1 ft between calculated surface water elevation from cleaned sensor depth reading and direct reading on staff gage
Dissolved oxygen	±0.3 mg/L between instrument reading at 100% saturation in air and expected solubility of oxygen	±2.0 mg/L or 20% between instrument reading at 100% saturation in air and expected solubility of oxygen, whichever is greater

N/A = Not applicable

FIGURES



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Stations are placed in 500-foot intervals. Station numbers indicate length along channel in hundreds of feet.
Aerial orthoimagery from USGS, June 2002.

Figure 1
Sediment Thickness Survey Results for Patrick Bayou
Work Package Two

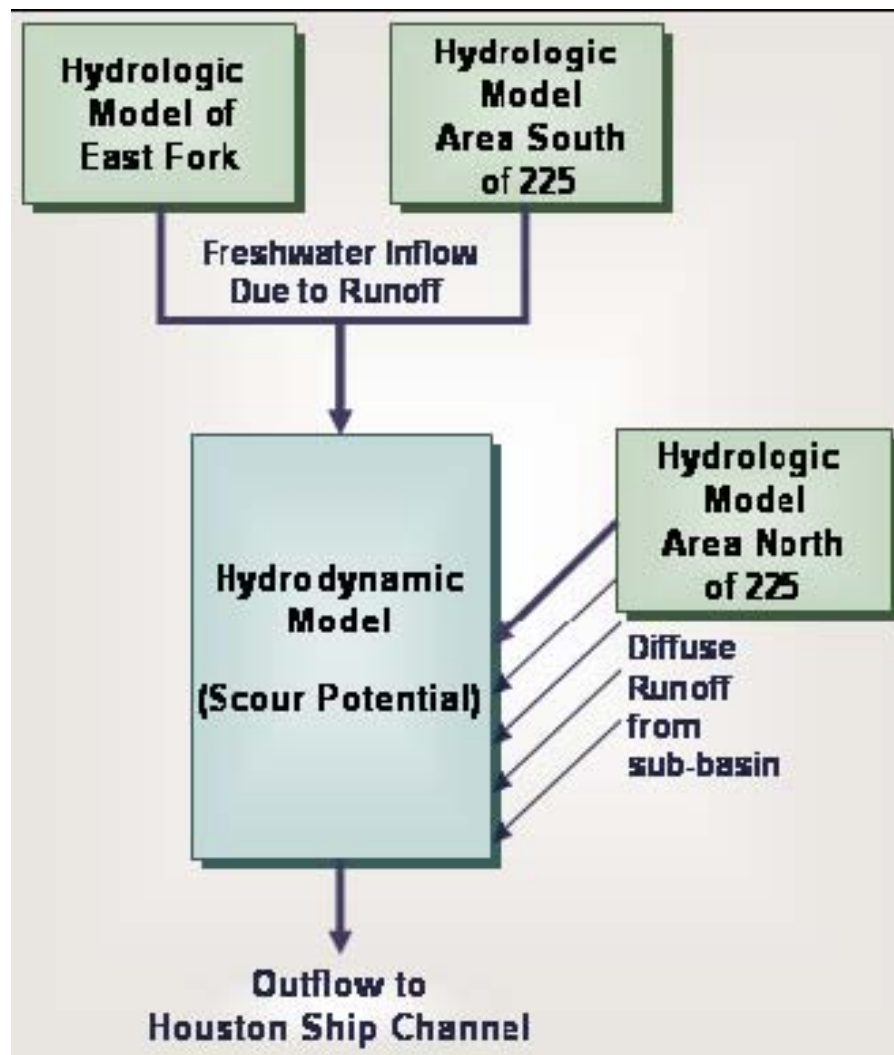
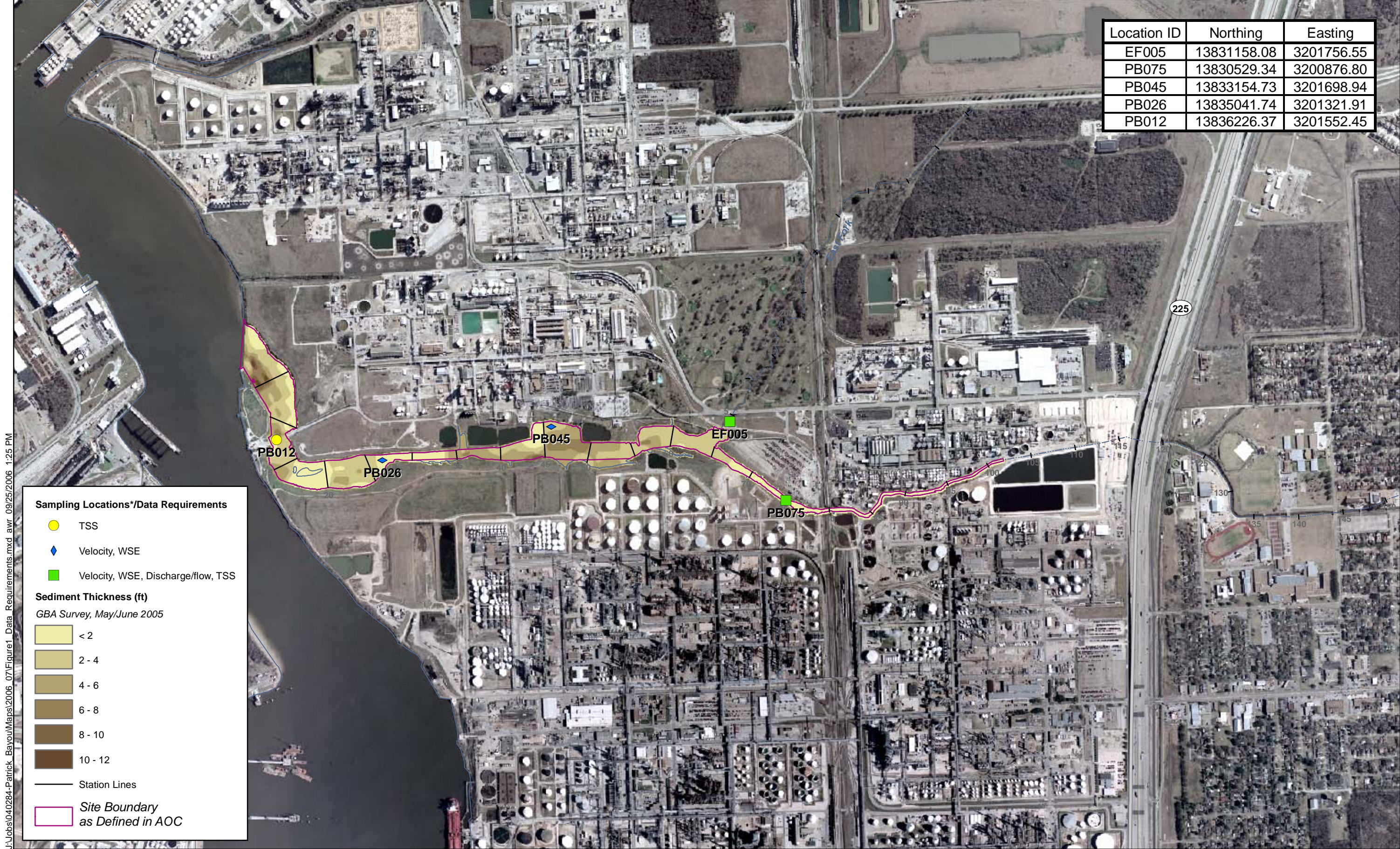


Figure 2
Conceptual Overview of Modeling Components and Linkages
for Patrick Bayou Hydrologic/Hydrodynamic Study



Location ID	Northing	Easting
EF005	13831158.08	3201756.55
PB075	13830529.34	3200876.80
PB045	13833154.73	3201698.94
PB026	13835041.74	3201321.91
PB012	13836226.37	3201552.45

Sampling Locations*/Data Requirements

●

 TSS

◆

 Velocity, WSE

■

 Velocity, WSE, Discharge/flow, TSS

Sediment Thickness (ft)
GBA Survey, May/June 2005

< 2

2 - 4

4 - 6

6 - 8

8 - 10

10 - 12

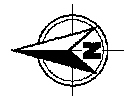
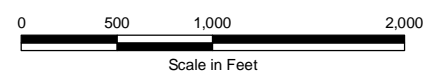
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 Station Lines

□

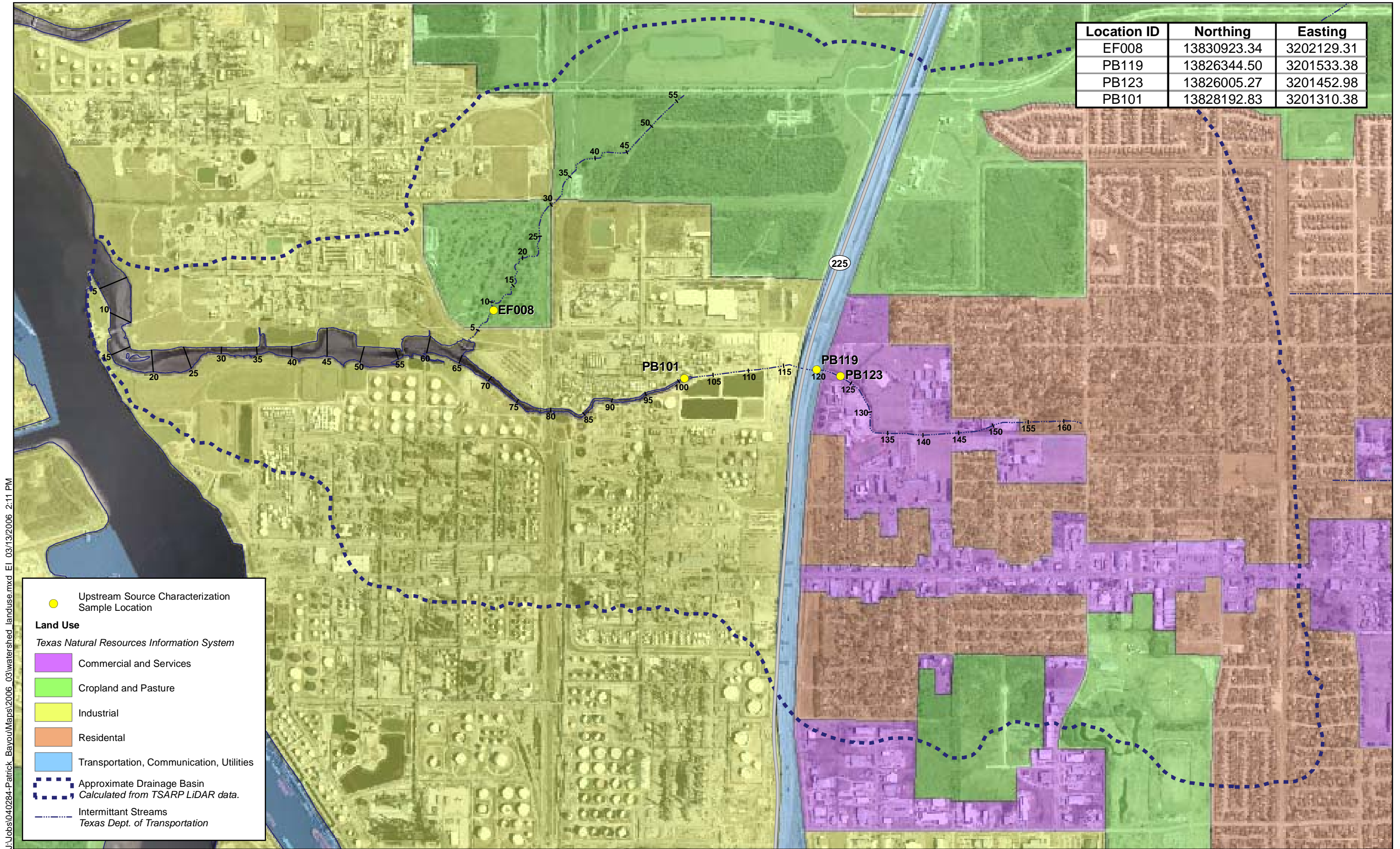
 Site Boundary
as Defined in AOC

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Station numbers from Patrick Bayou PSCR indicate length along channel in hundreds of feet. Aerial orthoimagery from USGS, June 2002.
*Please note station locations are approximate and may be relocated in the field depending on site conditions
Coordinate system NAD 1983 State Plane Texas South Central (feet)

Figure 3
Hydrodynamic Data Requirements and Sample Locations*
Work Package Two



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Location ID	Northing	Easting
PB009	13836190.69	3201850.92
PB016	13836120.76	3201194.62
PB030	13834707.34	3201335.33
PB042	13833551.36	3201354.53
EF001	13831226.21	3201612.72
PB067	13831216.18	3201354.56
PB077	13830368.06	3200780.25
PB018	13835837.70	3201070.29
PB073	13830742.28	3201037.34
PB094	13828774.24	3201009.01
PB063	13831338.02	3201542.97
PB003	13836425.37	3202339.46
PB022	13835498.23	3201097.95
PB036	13834114.31	3201378.46
PB048	13832959.40	3201502.80
PB057	13832096.55	3201519.36
PB084	13829634.22	3200707.36

Sampling Locations*

■

Verticle Profile Core Locations

■

Radioisotope Core Locations

Sediment Thickness (ft)
GBA Survey, May/June 2005

< 2

2 - 4

4 - 6

6 - 8

8 - 10

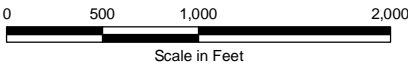
10 - 12

—

Station Lines

□

Site Boundary
as Defined in AOC



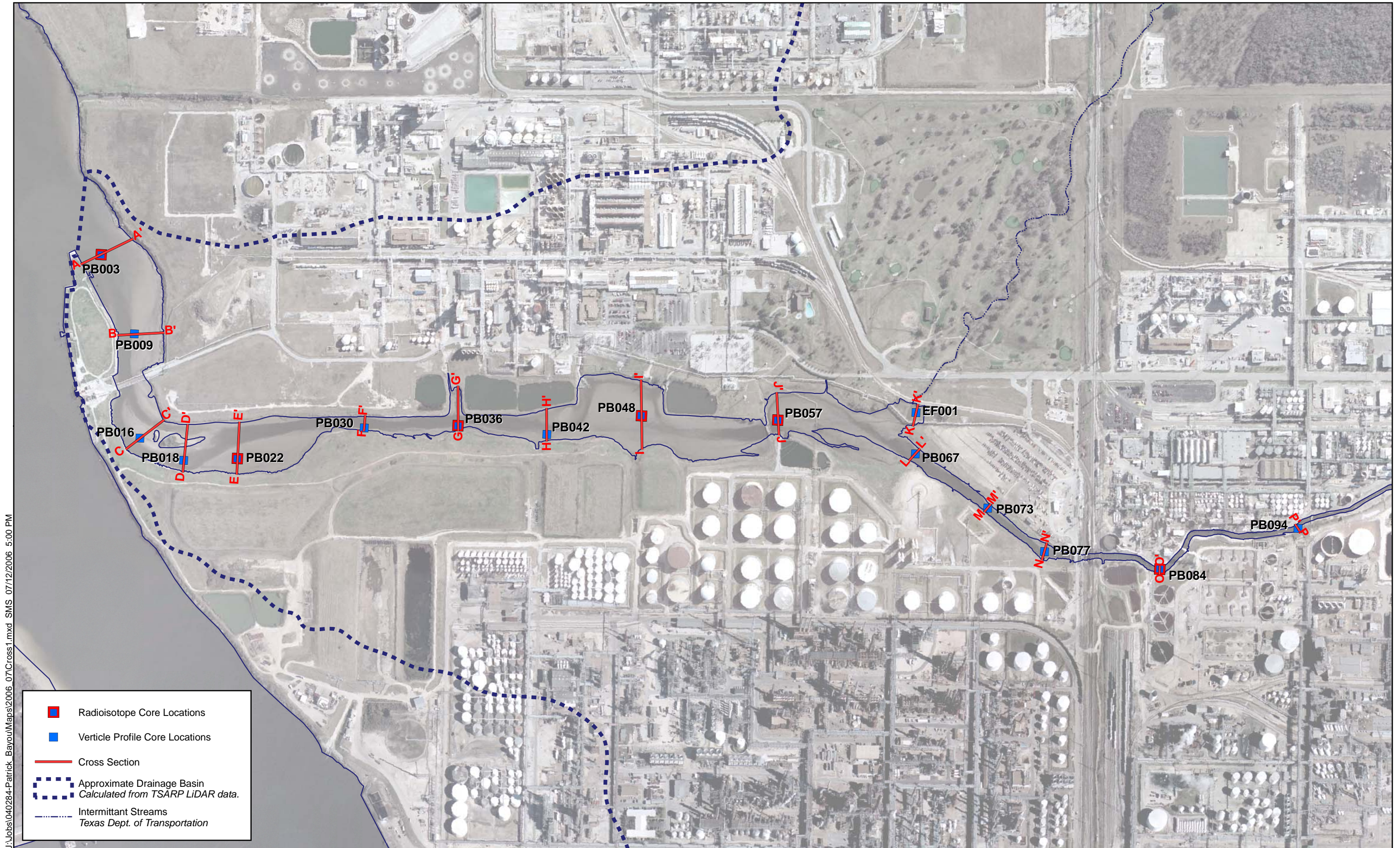
Station numbers from Patrick Bayou PSCR indicate length along channel in hundreds of feet. Aerial orthoimagery from USGS, June 2002.
*Please note station locations are approximate and may be relocated in the field depending on site conditions
Coordinate system NAD 1983 State Plane Texas South Central (feet)

Figure 5
Sampling Locations* for Vertical Characterization of COPC and Radioisotope Sampling in Patrick Bayou
Work Package Two



APPENDIX A

CROSS-SECTIONS SHOWING MUDLINE ELEVATIONS AND THE THICKNESS OF SOFT SEDIMENTS AT SELECTED SAMPLING LOCATIONS



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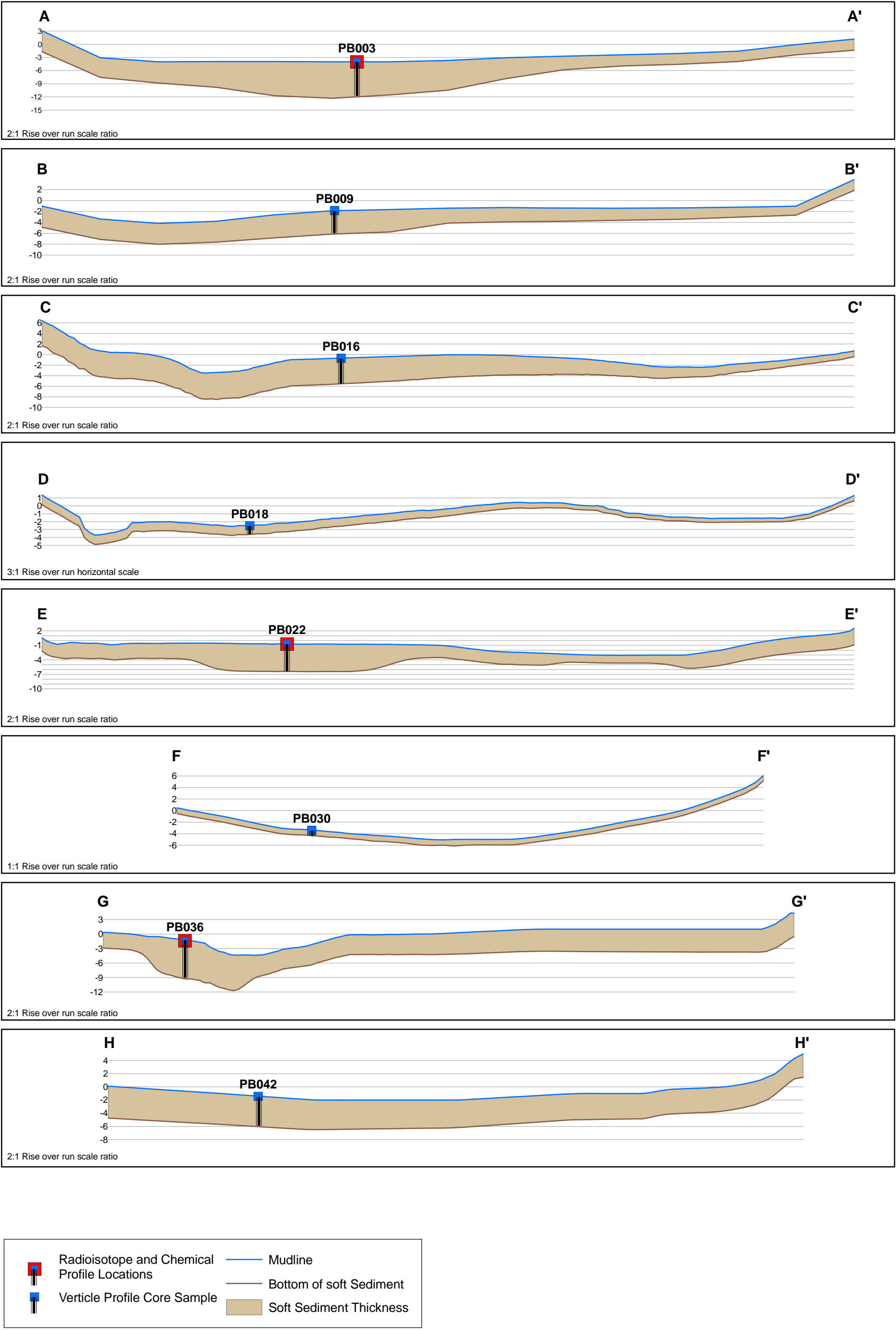


Figure A-2
Cross-Sections A-H Showing Mudline Elevations and the
Thickness of Soft Sediments at Selected Sampling Locations
Work Package Two

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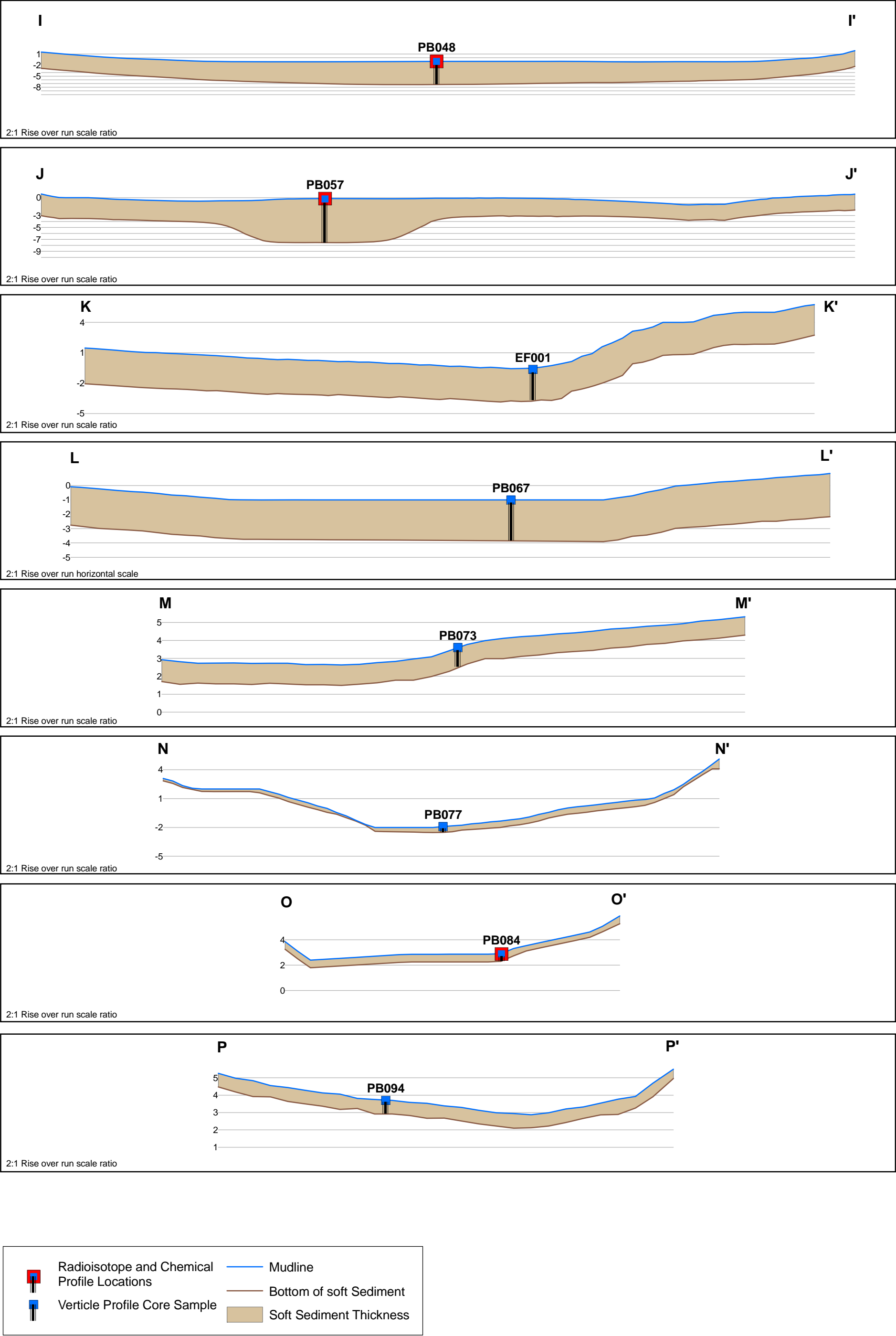


Figure A-3
Cross-Sections I-P Showing Mudline Elevations and the
Thickness of Soft Sediments at Selected Sampling Locations
Work Package Two